November 1991/$3.00

Mobile Radio Technology

The journal of mobile communications technology



Installation and Maintenance Issue
Troubleshooting mobile equipment
Installing cellular phones
Programming two-way radios
Modifying an amplifier deck

TENTEC PUBLICATION

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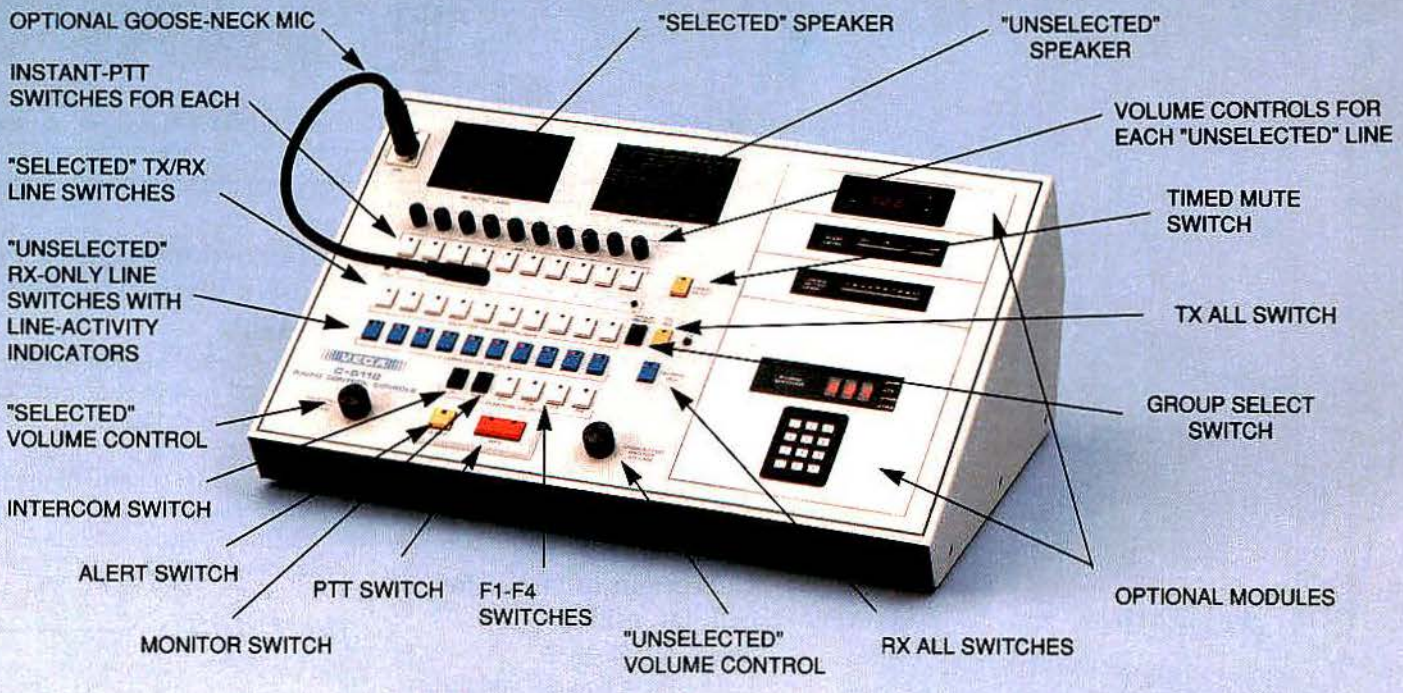
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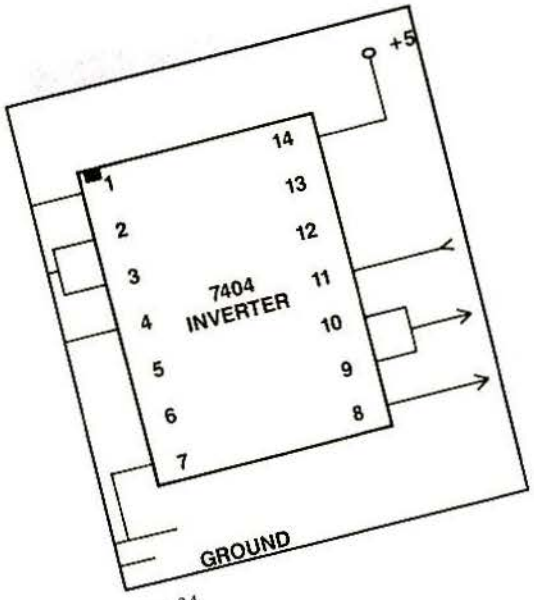
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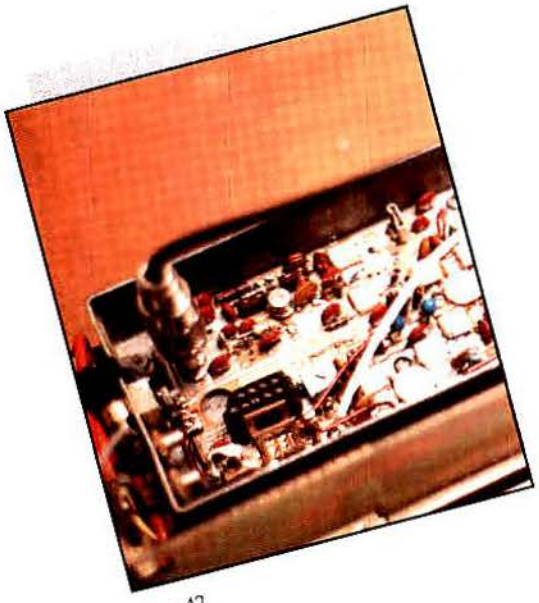
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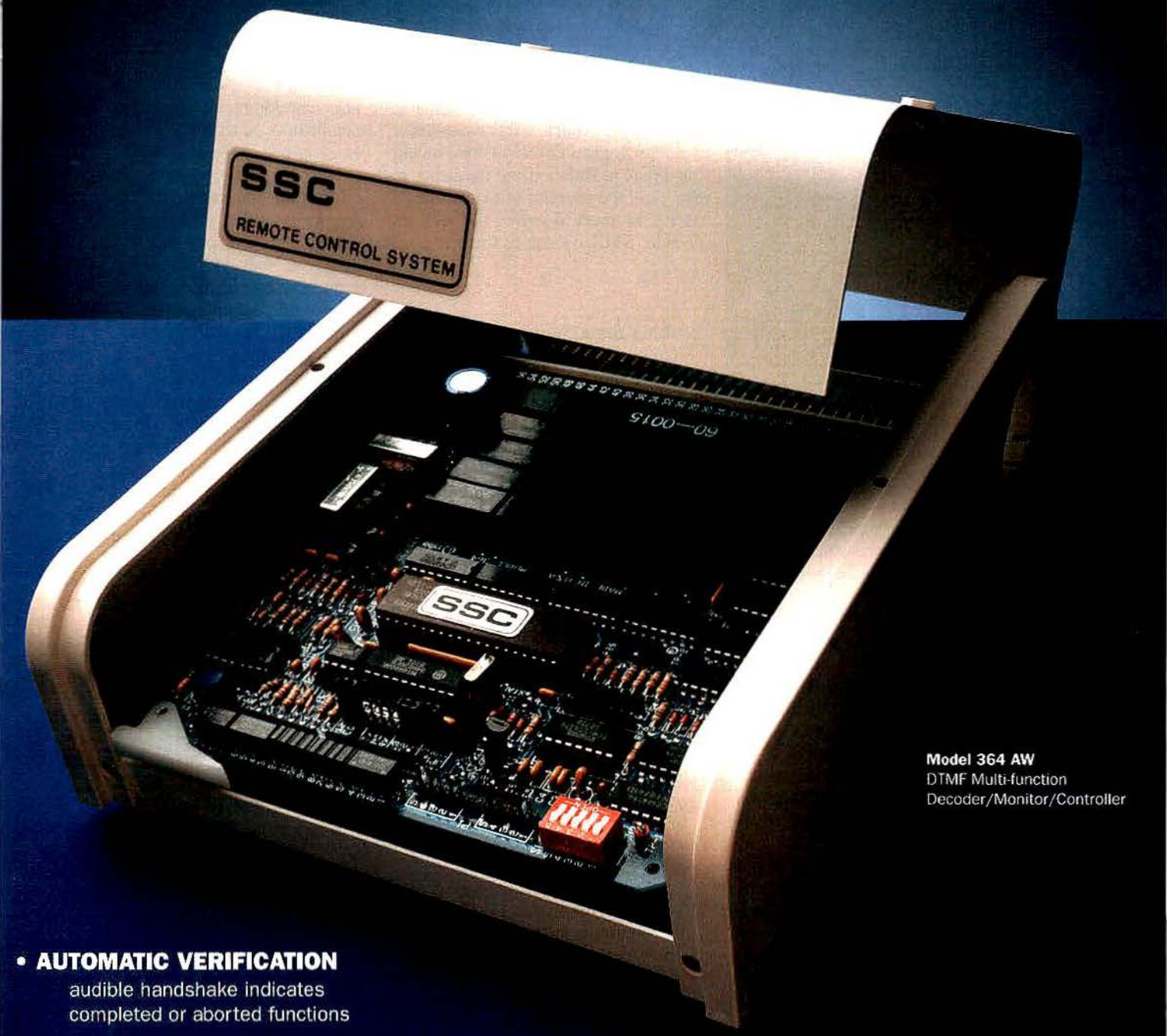
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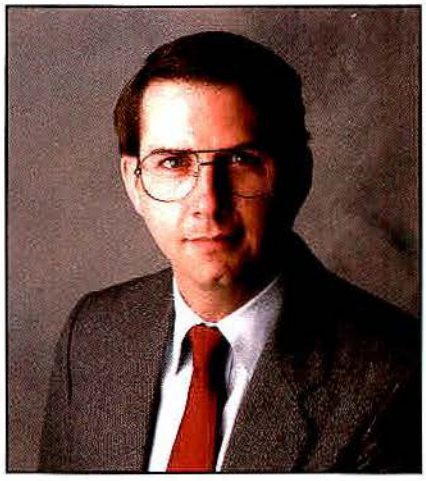
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Scanning...



SMR equilibrium

Specialized mobile radio (SMR) system construction appears to be finding a kind of equilibrium, a balance between supply and demand for mobile radio communications in some areas, and a depleted frequency supply in others.

One kind of balance is being struck outside the major metropolitan markets. In some of these areas, SMR licensees are abandoning their channels.

A survey conducted by the FCC Private Radio Bureau and inspections conducted by the agency's Field Operations Bureau found that about half of 110 licensees contacted had failed to build their systems. Trunked systems must be built within one year of the license grant. Single-channel systems must be built within eight months.

Meanwhile, the FCC has found that systems on most of the channels assigned in large metropolitan areas have been built. In those areas, demand for service continues to outstrip channel capacity. Where no additional channels are available, system construction has slowed.

In the middle-sized urban areas, SMR system construction continues, taking advantage of available 800MHz and 900MHz frequencies, including those abandoned by speculators who did not sell or construct their systems fast enough to meet FCC deadlines.

The SMR business continues to be healthy: It offers certain features and pricing that cannot be met by cellular mobile telephone, conventional two-way radio or radiopaging. SMR customers are loyal. Compared to cellular and paging, the SMR churn rate is much lower.

Technological developments, including digital modulation and frequency reuse, hold the promise of expanding capacity to meet demand. In its third decade, SMR continues to thrive.

* * *

Looking for a home

Radio systems that will support personal communications service (PCS) have to use a portion of radio spectrum. What frequency band PCS eventually will occupy is anybody's guess.

Most of the PCS experimenters endorse the 1.8GHz band. Some say low-power PCS equipment can share that band with current terrestrial microwave users without causing interference; some say it cannot.

Motorola plans to implement PCS in the 902MHz-to-928MHz industrial, scientific and medical band, though it does not necessarily see that band as a permanent home.

AT&T has eyes on the 6GHz band, a rather farsighted approach because expensive components are required to build radio equipment at such a high frequency.

* * *

Private carrier woes

We continue to receive complaints from readers who operate private carrier paging (PCP) systems and whose co-channel competitors will not cooperate to prevent interference.

Reasons for the lack of cooperation range from ignorance to indifference to connivance. Whether the interference is intentional or not, the situation in some locations has been described as chaos. One case that has received publicity lately involves a PCP operator whose subscribers left in droves because interference cut service quality. They didn't know why their messages failed to go through, but they knew the service was poor.

Methods for overcoming interference on PCP channels are well known. (See "How To Share Frequencies For Private Carrier Paging" in the August issue.) A key ingredient, cooperation among competitors on technical matters, apparently is not easily achieved.

In some cases we hear about, one competitor may cause deliberate interference on a PCP channel and not care whether its own paging messages are delivered. This willful interference may stem from animosity between an established radio common carrier (RCC) and a new PCP system operator.

An RCC channel assignment is exclusive to a licensee in a given geographic area. Thus, RCC signals normally are not subject to interference from competing paging systems. No cooperation among competitors is necessary.

But anyone may apply for a PCP license, including current RCC licensees. Some PCP operators have charged that some RCC competitors have built transmitters on the shared PCP channels for the sole purpose of causing interference to their new competitors.

The message traffic broadcast over the common carrier's PCP transmitter duplicates message traffic being carried over the RCC channels. Customers receive their paging messages on pagers tuned to the RCC channel. The same messages broadcast on the PCP channel only serve to interfere with the RCC's private carrier competitors who share the channel.

When the interference is intentional, as it is in this type of situation, there is little hope for a technical solution. Assistance from the frequency coordinator; mediation and possible administrative action by the FCC; and litigation through the federal courts may be required before a technical solution is applied.

—Don Bishop

PRIVACY NEWS from transcrypt

Volume 1, No. 5

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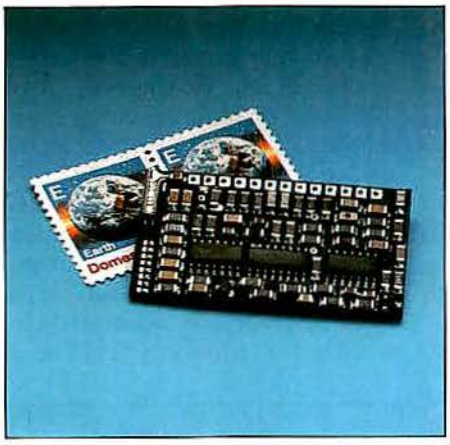
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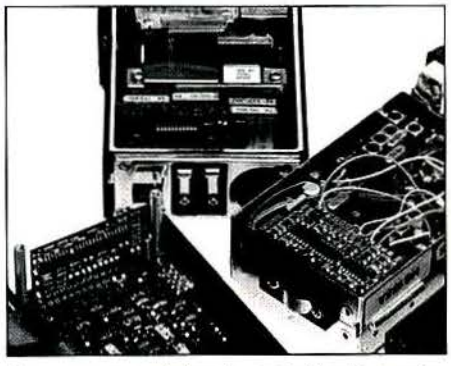
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Letters to the editor

Unlicensed radio:

In your August "Letters to the Editor" section, Clarence Gates Jr. wrote about his concerns with unlicensed radio operations. Some of his points were right on track. Unlicensed radios are indeed a growing problem, and the FCC's deregulation and the availability of programmable radios combine to make it worse.

Where I differ with Gates is his assertion: "Local law enforcement agencies should have the authority to check for and to prosecute users who possess unlicensed transmitting equipment ..."

Law enforcement has enough difficulty in trying to check vehicles belonging to burglars and drug distributors. Aside from the legal issues, checking for unlicensed radio transmitters would rank in importance with prosecuting supermarkets for selling cigarettes to minors. Do you have any idea of the workload of the average police officer today?

I believe you would be amazed at the number of law enforcement agencies which are merrily operating their own radio stations—and mobile units—with expired licenses; and some without ever having one.

This is the wrong solution.

Alan Burton
Editor
Dispatch Monthly Newsletter
and retired captain of the Contra Costa (CA) Sheriff's Department

Technical skills:

I read with interest and concern the letter from John Hokenson in the June 1991 issue on technical competence in mobile radio. I am an educator and took my job with the hope of improving U.S. competitiveness in the wireless communications field. In fact, in graduate school my observations about America's technical expertise were similar to those made by Hokenson and caused me to wonder how effective I could be as a teacher and researcher at a major university. Truthfully, I was worried that the lethargy of today's American college student would be too disappointing to handle on a day-to-day basis.

I am delighted and relieved to tell you that my fears have been largely unfounded. I have been amazed at the tenacity and good work ethic of graduate students, who are developing knowledge of cellular radio and personal communications. I have seen students who lacked confidence go on to lead a research program, while maintaining excellent grades and taking care of the intricate details needed to make experiments work flawlessly. I have walked into my laboratory at 2 a.m. only to find five or six students working on their research.

I get discouraged sometimes when a large class moans about a homework assignment that was "too hard or too lengthy," but I have had those same students tell me a year out of school that it was worth it and they are better en-

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The journal of mobile communications technology

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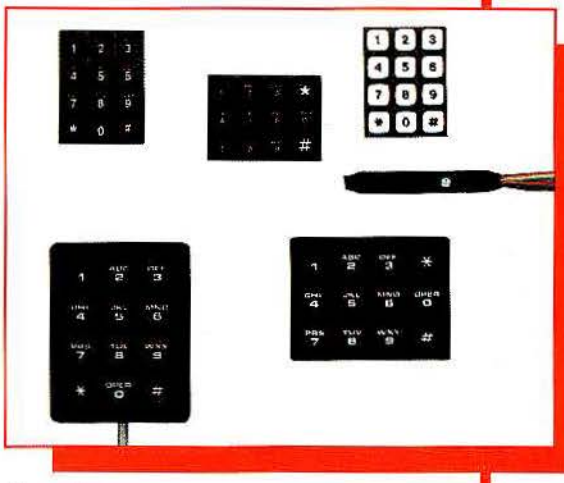
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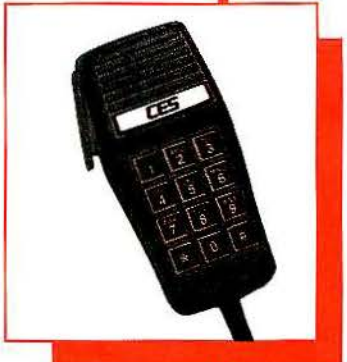


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Make The RIGHT Connection

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gineers because of the work.

I agree with Hokenson that the American work ethic is perhaps not what it once was, and I hold great hope for the present generation of students. With encouragement from faculty and a commitment to state-of-the-art teaching facilities, America will continue to hold its own in the technical world.

It is this commitment, and not the students, that worries me the most. A good-quality education must be made available to all Americans, no matter where they live or what their background. Children must develop a love for learning, and this responsibility rests with the family and the grade school and high school teacher. Consequently, upholding traditional family values and recruiting the best school teachers should be our country's top priorities if we want to maintain our competitive advantage in technology. It distresses me, though, to see grade school and high school teachers receive relatively poor pay and little community recognition when compared with their counterparts in other parts of the world.

Education of our youth is the only sure way to keep America competitive. Grade school teachers should be celebrities in their community and should be given drastically higher pay to encourage the best people to educate our future work force.

Parents must get into the classroom and help the teachers promote the values that made us dominant in technology. Business and government *must be made aware* by employees and constituencies that education of our youth is a No. 1 priority and the future of our nation is at stake.

If not, I am afraid that there eventually may be an entire generation that possesses a lack of will to learn, as exemplified by Hokenson's experiences.

Theodore S. Rappaport
Assistant Professor of Electrical Engineering
Mobile & Portable Radio Research Group
Virginia Polytechnic Institute & State University
Blacksburg, VA

From Fast Fact Cards:

The March issue addresses my interests as a site operator.

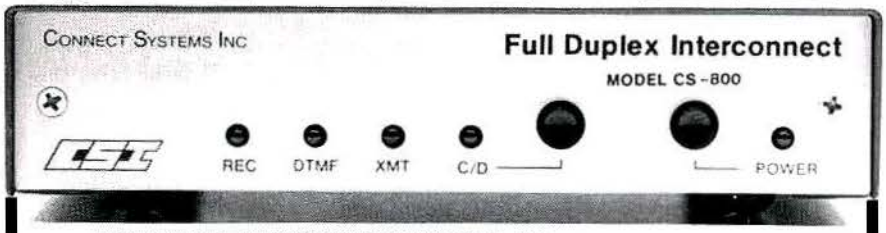
The most interesting article in the issue is "How To Specify And Monitor Your Tower Installation" by John W. Crooks.

The two toughest problems facing me on the job include:

- finding technical staff who also can be customer service people. In a small operation, it is important that sometimes a few people do the work of both service and clerical employees.
- finding *continual* financing to purchase more pagers and transmitters to expand.

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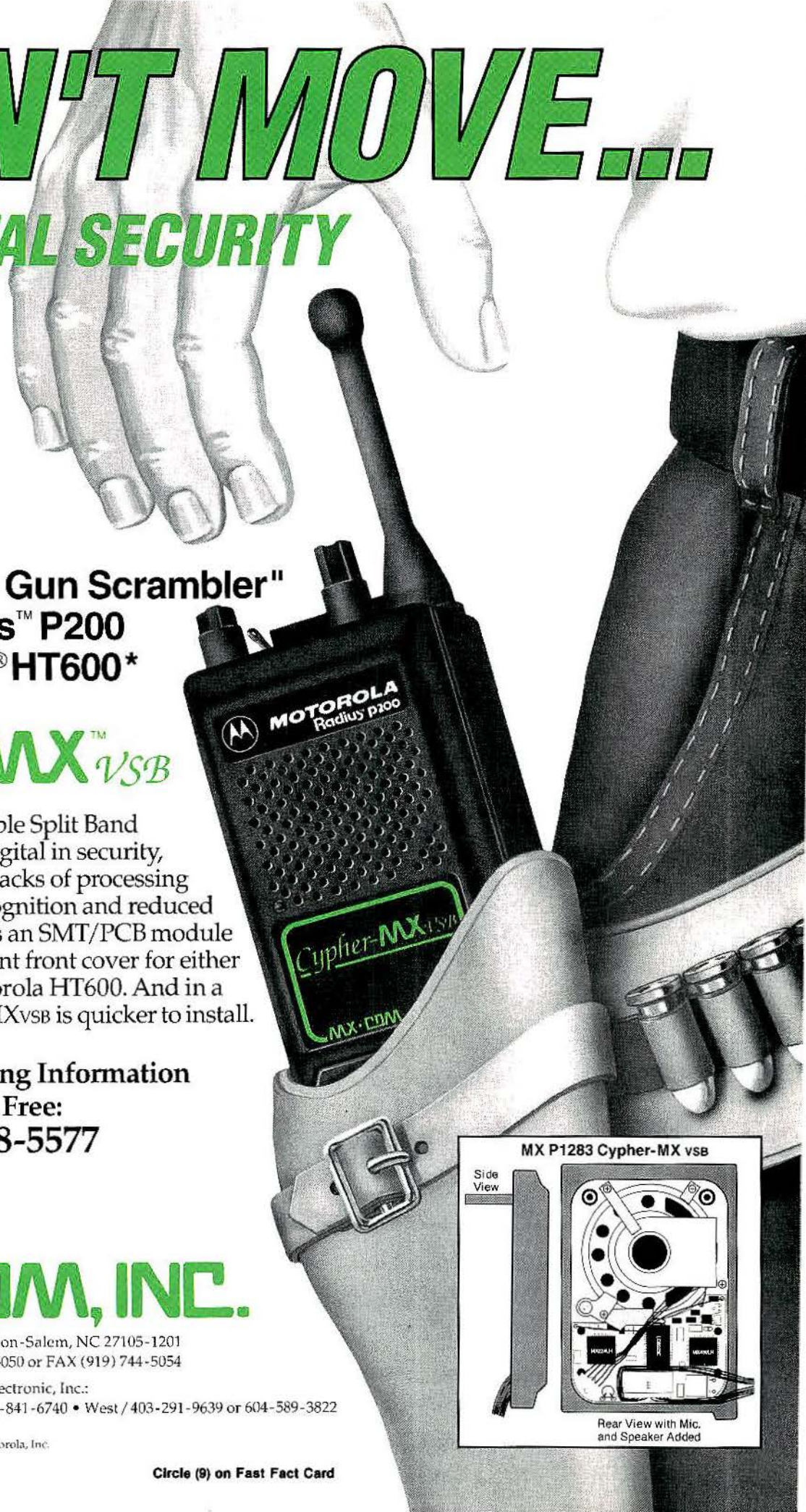
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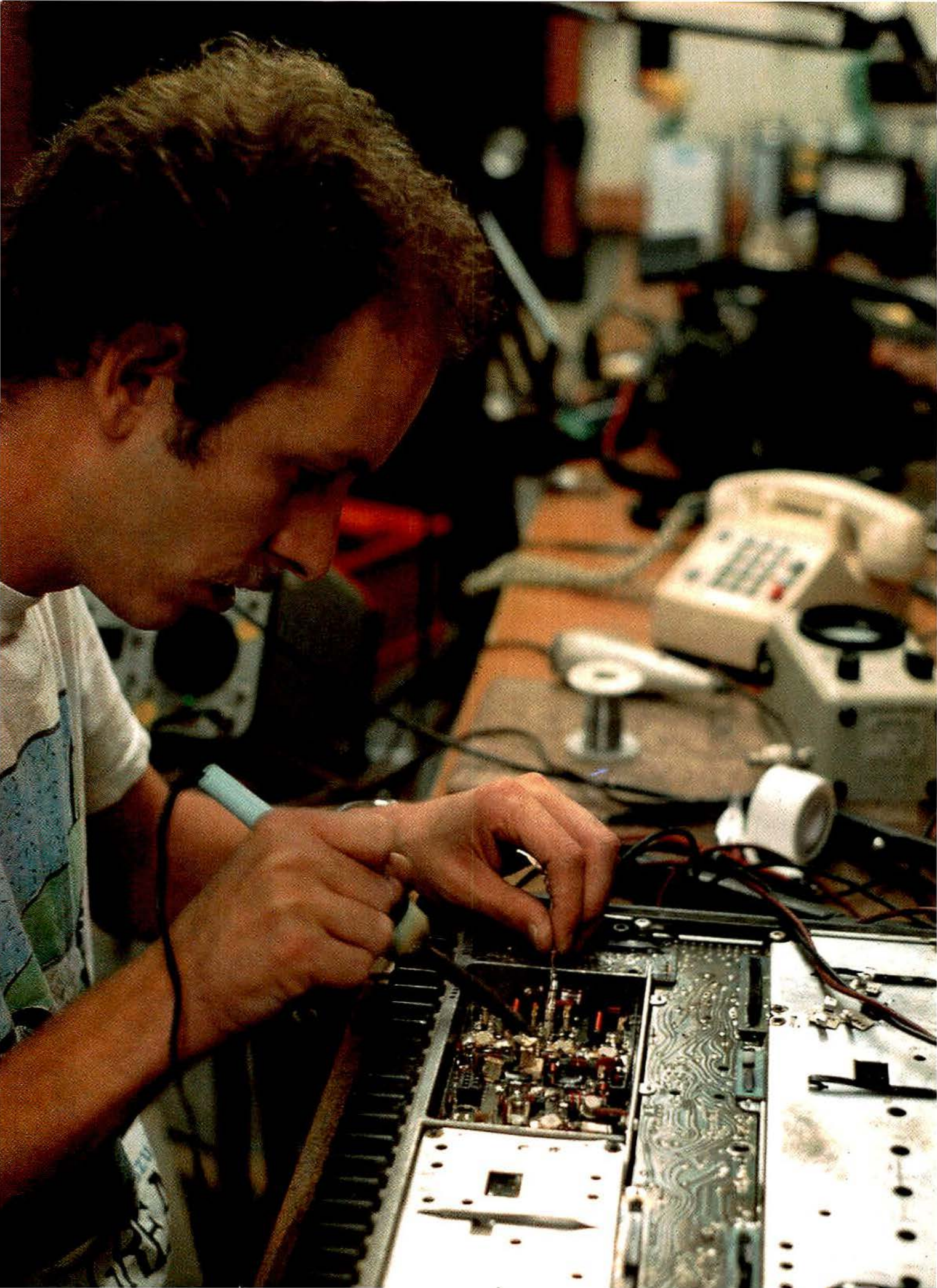
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How to troubleshoot land mobile equipment

Five case histories offer examples of logical troubleshooting methods. Simple test procedures isolate short circuits and other electronic faults to restore land mobile radio equipment to service.

By Harold Kinley, CET

Troubleshooting modern land mobile radio equipment requires more proficiency than ever before. Many factors have contributed to this situation. Some of them are: the invasion of digital technology, integrated circuit technology (from small-scale to very-large-scale integration) and surface-mount technology using chip components.

Fortunately, advances in test equipment have come about because of some of the same factors. These test equipment advances help to offset, somewhat, the problems associated with servicing the new-technology land mobile radio equipment.

Nevertheless, modern test equipment alone is not the answer to meeting the challenge. The technician must know how to use the test equipment and apply modern troubleshooting techniques.

Here are some pointers that help technicians become more efficient at troubleshooting:

(1) Make it a point to understand the circuit under test. If you do not understand how it is supposed to work, you will not be able to troubleshoot it efficiently. Hit-or-miss techniques more often miss, wasting time and effort.

(2) Take the necessary time to become familiar with your test equipment before the need to use it arises. If you have to stop in the middle of a job to familiarize yourself with your test equipment, you lose time and, probably, money.

(3) Try to be objective. Do not guess at the outset that a particular part is bad and then set out to prove that your guess is right. Instead, let the results of each methodical test procedure point you in the right direction until you have narrowed the problem down to a particular component. It is okay to try the simple things first, but do not waste time chasing wild hunches.

(4) Make it a point to know how to perform basic EIA test procedures to ascertain that the radio equipment is performing within specifications before it leaves your hands. This helps your reputation, as well as the service shop's.

(5) Familiarity with various troubleshooting procedures is a *must*. The exact procedure you will use is determined by the problem you are troubleshooting, the type of equipment available and your experience.

If you are inexperienced at troubleshooting land mobile radio equipment, do not be intimidated when faced with a new troubleshooting problem. Remember, everyone was a beginner once, and the only way to become proficient is through experience.

After each repair job, ask yourself how you could have repaired the equipment more efficiently, which troubleshooting procedures were proper, which were not and what procedures would have led you to the solution faster. By doing this, you will be better prepared for the next job.

The following servicing case histories provide the beginner with some insight on troubleshooting land mobile radio equipment. They are not particularly difficult cases, and they are typical of everyday servicing problems—with a mix of old and new technology.

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. He has written many technical articles on various aspects of radio-electronics. He is the author of *Standard Radio Communications Manual With Instrumentation and Testing Techniques*, Prentice-Hall, 1985.

Case history No. 1

The complaint on a Motorola Mocom 70 VHF highband radio set: It is "not receiving."

As usual, the first step is to hook the radio up to the workbench test setup to verify the complaint. When the squelch control is turned up, there is plenty of noise from the test speaker, verifying that the audio stages are working. The current drain as indicated on the bench power supply ammeter appears about normal, so apparently there are no short circuits.

Next, an on-frequency FM signal is applied to the receiver input. There is no evidence of the applied signal in the speaker until the signal generator output is turned up to a high level. This verifies that the receiver's local oscillators are working. If they weren't, it would have been impossible to force even a strong signal through the receiver.

At this point, it seems the proper thing to do is to start signal-tracing. An ordinary ×10 (times 10) scope probe is connected to the spectrum analyzer antenna input to trace the signal. With a strong CW signal feeding the receiver input from a separate signal generator, signal tracing begins. (See Figure 1 on page 12.)

With the spectrum analyzer tuned to the receiver frequency (159.270MHz), the test probe's first stop is at the first mixer transistor's (Q2) gate. A reference

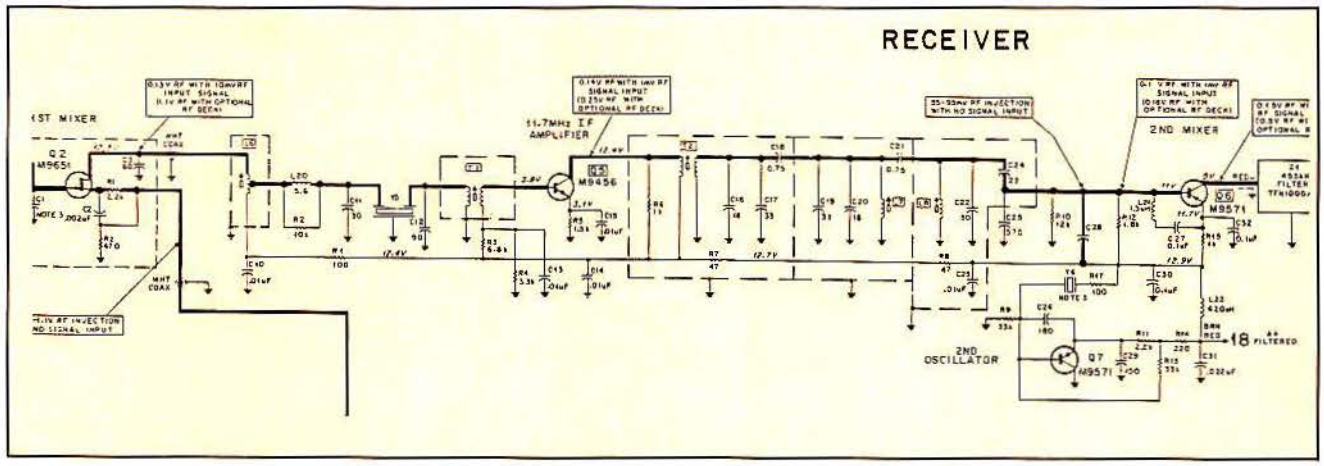


Figure 1. The first and second mixers, along with the high IF stage of the Mocom 70, are shown. L22 is at the far right. An open L22 killed the supply voltage for the first and second mixers and the high IF stage, causing the receiver to exhibit extremely poor sensitivity.

reading is taken here for comparison.

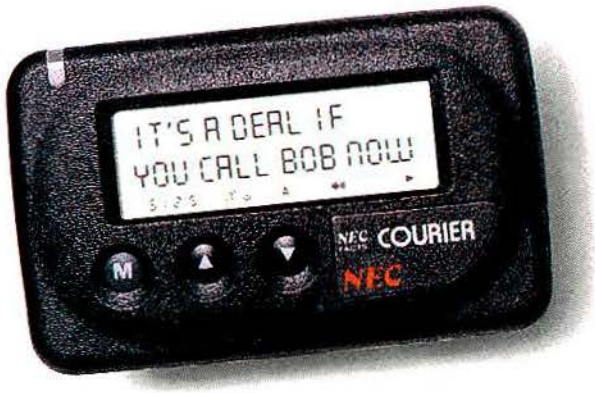
Then the probe is moved to Q2's drain, and the spectrum analyzer is tuned to the first IF frequency of 11.7MHz. Signal amplitude at the Q2 drain is much lower than its amplitude at the gate, indicating the mixer is causing a large signal amplitude loss in the conversion process. The mixer should provide a considerable conversion *gain*, not a loss.

At this point, voltage measurements around the first mixer are indicated. The digital voltmeter probe is touched to Q2's drain. The dc voltage at this point should be around 12Vdc, but instead it is 0V. A quick study of the schematic (Figure 1) reveals that Q2's supply voltage comes from point 18 (A+ filtered). The voltage at point 18 is checked and found to be normal.

Next the voltage on L22's load side is checked and found to be zero. *L22 is open*. Because this point also is the first



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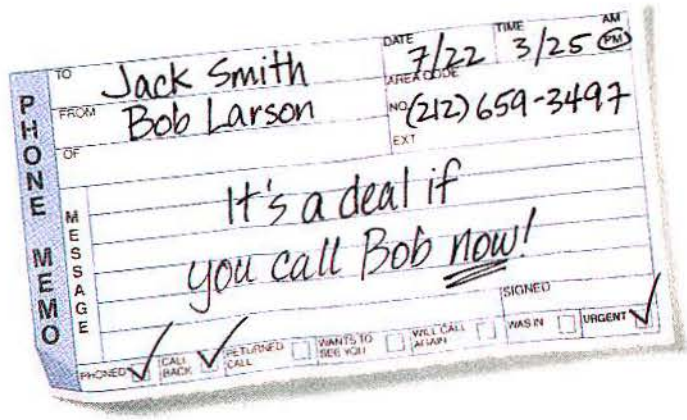
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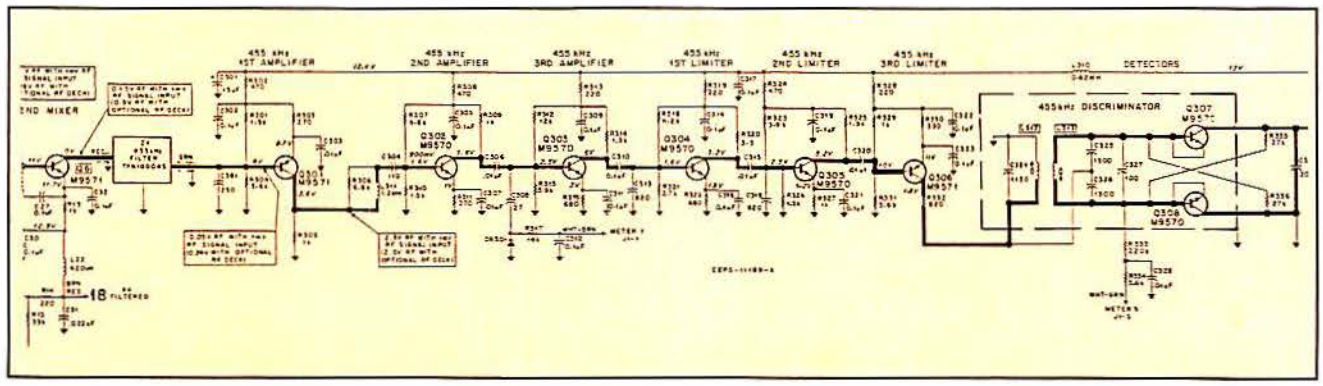


Figure 2. The low IF and limiter stages of the Mocom 70 are shown. A shorted C301 (top left) killed the dc supply voltage to these stages and caused L310 (top right) to overheat.

IF amplifier transistor stage's voltage supply, it is no wonder that the receiver is so unresponsive to a signal input.

After replacing L22 and running a comprehensive performance check on the set, the repair is complete.

Case history No. 2

The complaint on this Motorola Mocom 70 VHF highband radio is the same: It is "not receiving."

The workbench power supply is connected to the set and power is applied. The power supply ammeter indicates a current drain of 750mA, which is excessive for the receive standby mode.

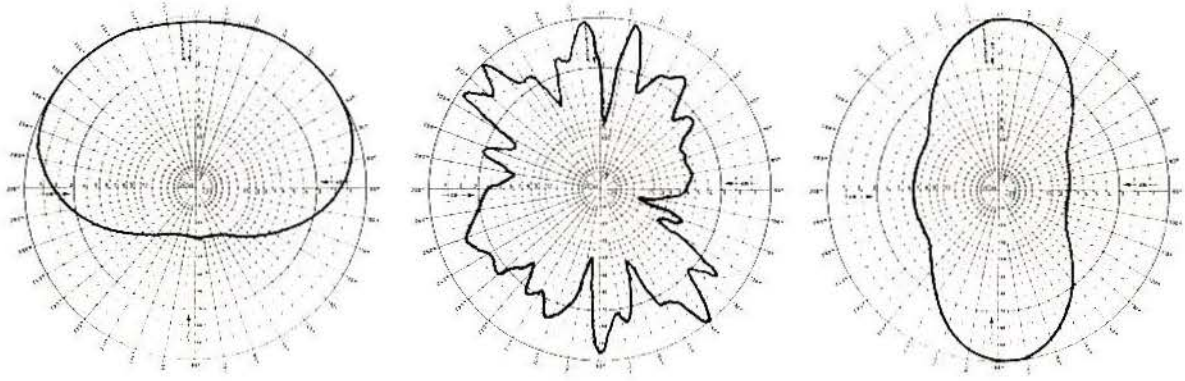
There is no smoke, but my nose tells me something is getting warm. Carefully touching my fingers to various components around the area where the odor is coming from, I find that L310 is getting warm to the touch.

An ohmmeter reading confirms there is a short circuit on L310's load side. L310 supplies A+ voltage to the low IF amplifier and limiter stages. (See Figure 2 above.) Studying the schematic reveals two prime suspects: Either C301, a 15μF capacitor, or C317, a 0.1μF capacitor probably was shorted. These are prime suspects because there are no other direct paths to ground. Other possible paths to ground are isolated by

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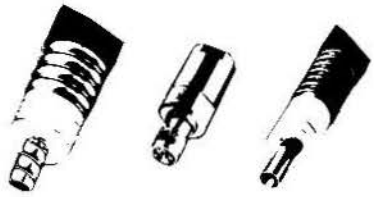
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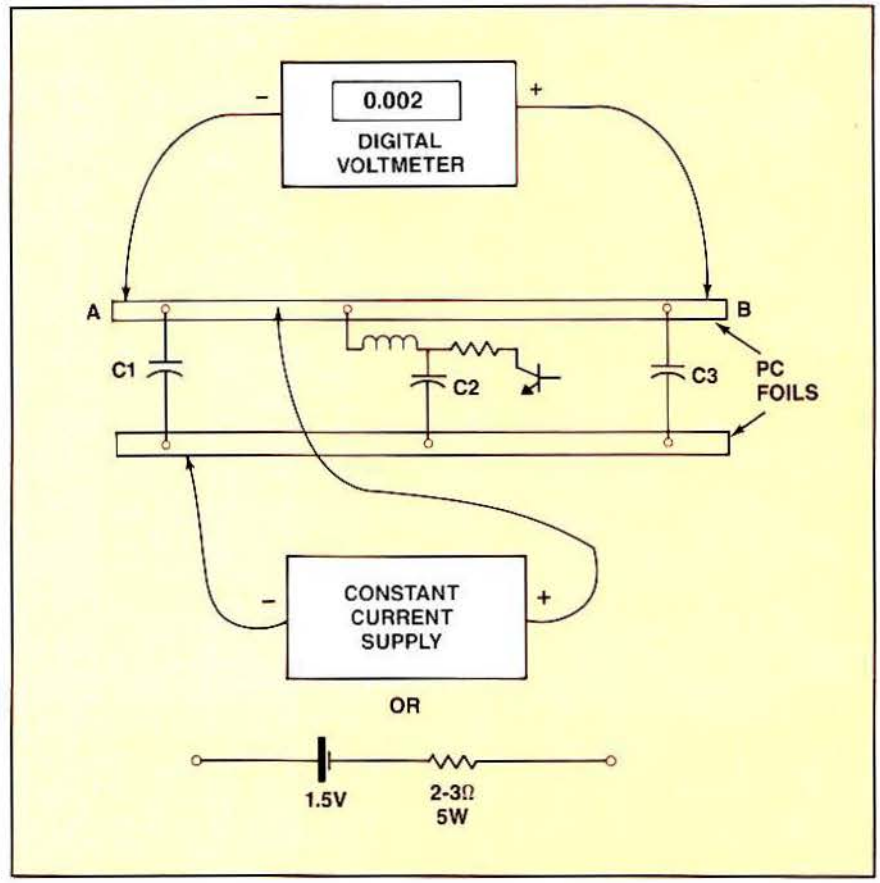


Figure 3. This is the setup for using a digital voltmeter and a current supply to locate the exact position of a short circuit on a pc board.

resistors.

To pinpoint either C301 or C317 as the cause of the short circuit, a Shortsqueek instrument is used. This instrument generates a high-pitched tone when its two probes are placed across a low resistance. The lower the resistance, the higher the frequency. Thus, this instrument can locate short circuits on printed circuit boards where the pc foil resistance is sufficient to make a perceptible difference in the tone's pitch.

First, the probes are touched to points on the pc board where C317 connects and the tone pitch is noted. Next the probes are touched to points on the pc board where C301 connects and, again, the tone pitch is noted. The tone pitch is definitely higher with the probes connected across C301. C301 is removed and tested with an ohmmeter, which shows it is shorted.

If you do not have a Shortsqueek instrument, you can use another method to locate short circuits on pc boards. It involves using a digital voltmeter that reads down to millivolts, and a current source. The method works on the same principle as the Shortsqueek instrument does—that is, the pc foil has a small amount of resistance that can be used to an advantage in finding short circuits. (See Figure 3 above.)

If you have a constant-current supply, set the supply to limit current to 0.5A to 1A. Alternatively, you can use a 1.5Vdc cell with a series resistor. Select the resistor value to limit current to the desired level.

In the circuit shown in Figure 3, the short circuit has been narrowed down to a location between points A and B on the pc foil and ground. With power removed from the device under test, the digital voltmeter is connected to points A and B and set to its lowest voltage range.

Leads from the current supply are connected across various branches of the circuit until the voltmeter reads zero. The short circuit is at the point where the leads are connected when the voltmeter reads zero.

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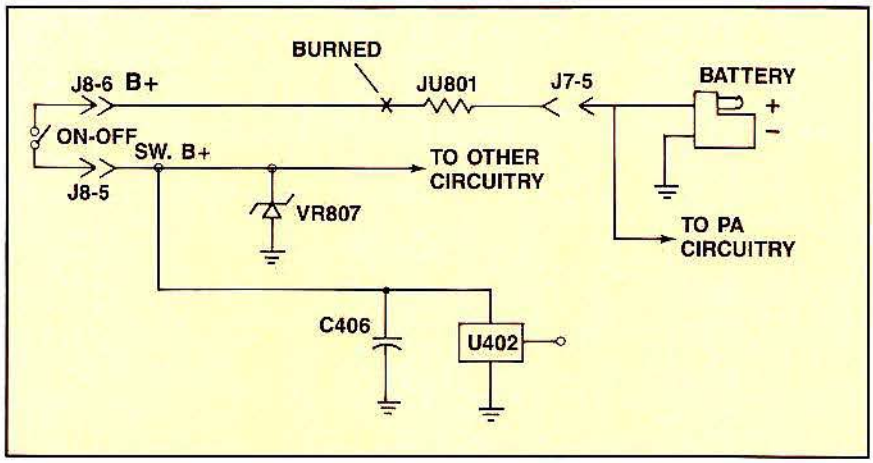


Figure 4. A shorted VR807 caused the pc trace to burn out at the spot marked with an X on the drawing.

you are moving the current supply leads toward the short circuit. When the current source is connected between the point of the short and the digital voltmeter's positive lead, the voltmeter reading is positive. When the current source is connected between the voltmeter's negative lead and the short, the voltmeter reading is negative. As you move the current supply leads toward the short, the voltmeter reading drops toward zero.

Assuming that C1 in Figure 3 is shorted, the voltmeter reads zero when the current supply is connected across C1.

If the voltmeter reading is insufficient to determine the short circuit's exact location, you may have to increase current. Be careful not to damage the board with too much current. Touch the leads from the current supply to the board briefly, just long enough to get a reading. The amount of current required is determined by the pc foil strip's width and thickness (resistance).

This procedure may be a lot of trouble to find a short circuit, but it is much easier than indiscriminately disconnecting various branches from the circuit one at a time to find the branch with the short circuit.

Case history No. 3

The problem with a Maxtrac 300 VHF set is a strange one. It makes a loud squeal at times but there is no note to say under what conditions.

The set is installed on a crawler tractor used for fire suppression. The set is turned on and checked for proper operation in the tractor. With the engine off, it works fine. With the engine idling, the radio is normal. But when the

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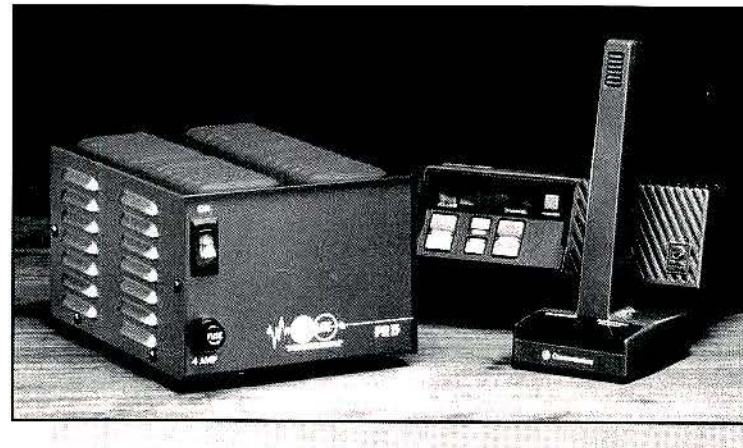
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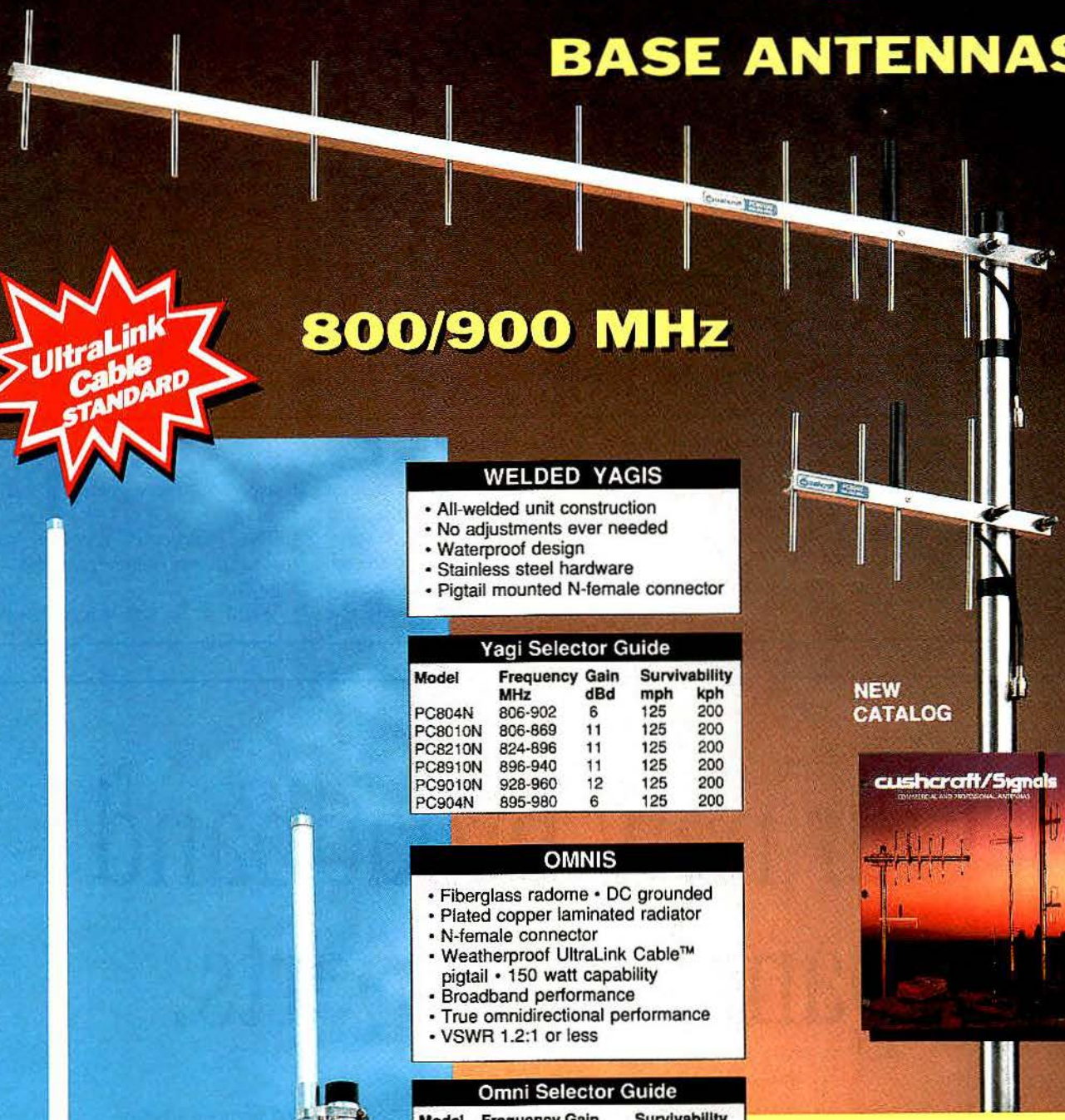
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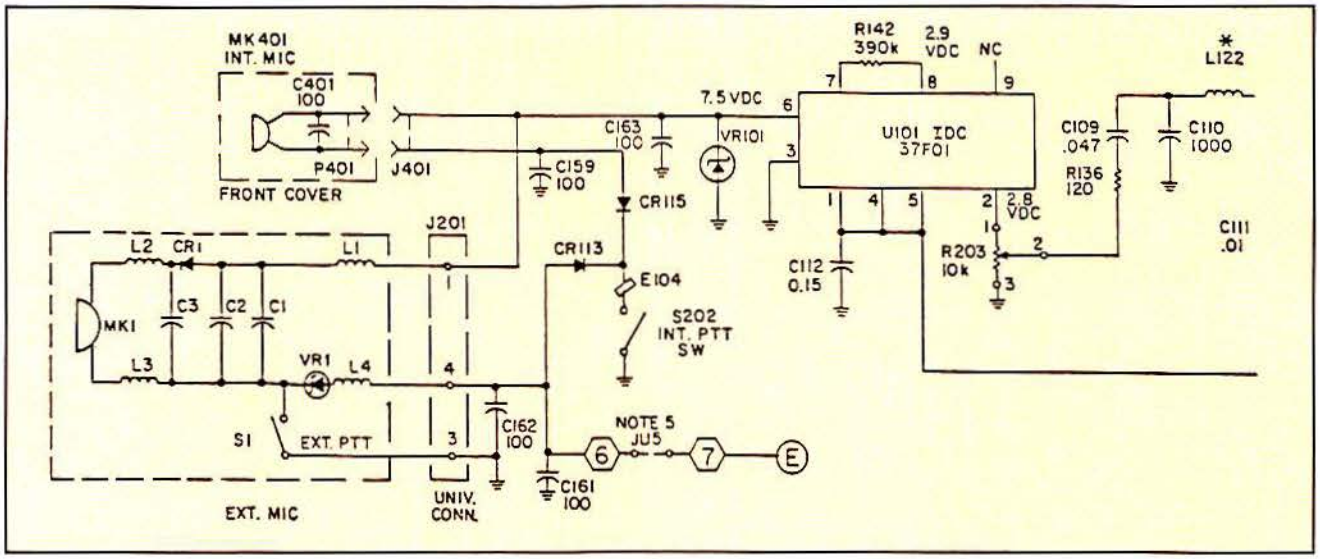


Figure 5. The mic audio/IDC IC gain is controlled by R142 at the top of U101.

engine's rpm is increased, the radio goes into an uncontrollable, loud squeal. The squeal keeps up until the engine is shut off and the radio is turned off. When the radio is turned on again, it works normally.

A voltmeter is connected to monitor battery voltage, and the engine is started. The voltage rises steadily. When it reaches 16V, the radio begins its uncontrollable squeal. The radio and tractor engine are turned off. Obviously, the tractor's voltage regulator is malfunctioning.

The trouble is reported to the mechanic, who then repairs the voltage regulator.

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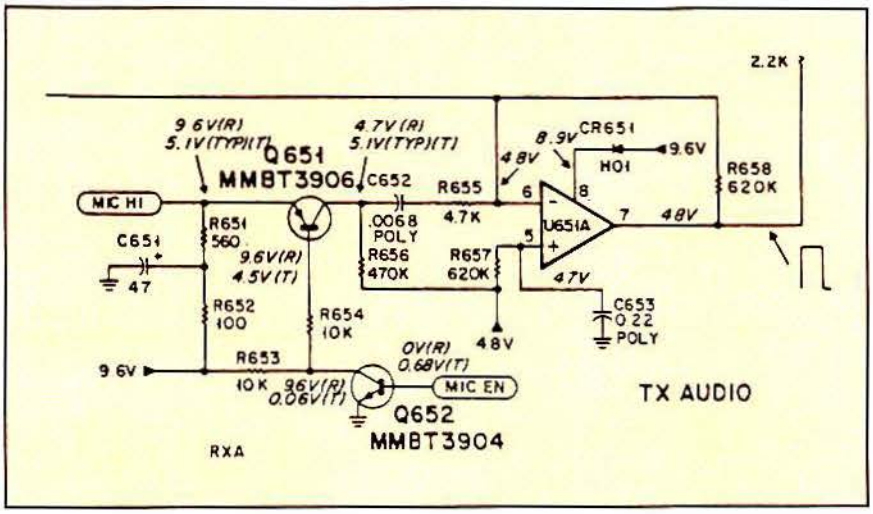


Figure 6. The Maxtrac 300 mic amplifier is shown. Reducing R658 to approximately 120K solved the problem of excessive background noise on a diesel crawler tractor, allowing the operator to be heard over the radio with the engine running.

thing causes the radio to go dead.

The radio is removed from the tractor and placed on the workbench for troubleshooting. The cover is removed, and the radio is inspected for damage. An odor indicates that something inside the set has burned.

Inspection with a magnifying glass reveals a spot where the pc foil had burned open. The foil is repaired with a short piece of hookup wire soldered in place to bypass the burned spot.

A short circuit must have caused the foil trace to burn open. (See Figure 4 on page 18.) An ohmmeter is used to check for a short circuit at the voltage supply input at J2. With the radio switched off, the meter indicates no short. With the switch turned on, the meter indicates a short, meaning the short is on the opposite side of the switch from where the meter is connected.

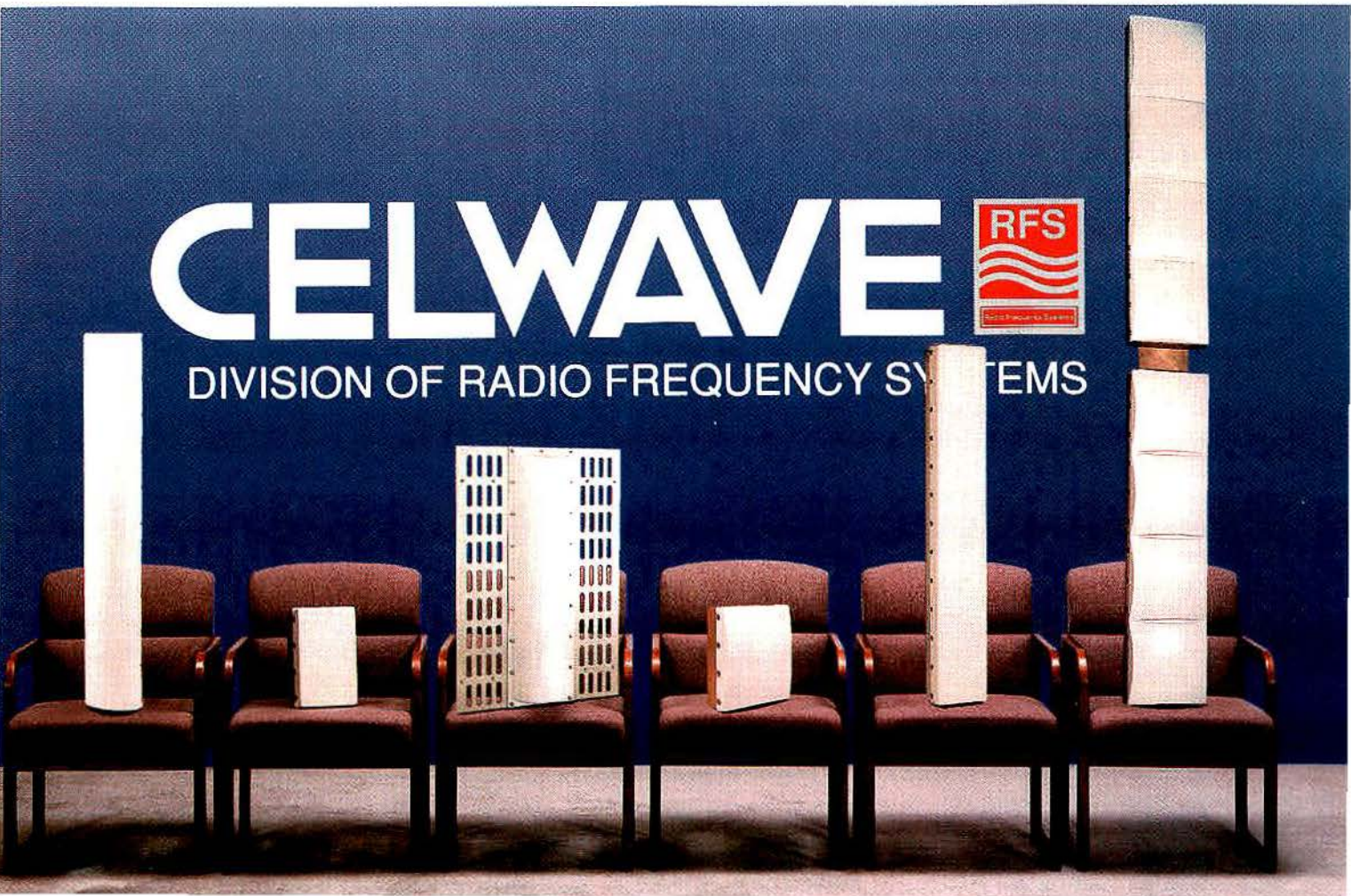
With the help of a Shortsqueek instrument, the short is located at VR807. Replacing VR807 cures the problem. A performance test verifies that the set is once again in working order.

Case history No. 4

The problem is with an HT440 Motorola hand-held. The unit is installed in a diesel truck in a vehicular communications adapter (VCA). The complaint is "motor noise."

The expectation: that alternator whine would be heard when the radio was checked in the vehicle.

Instead, the noise was not caused by



any defect in the truck. It was caused by excessive gain in the radio transmitter's audio stages. When the truck was running, acoustic noise from the loud diesel engine was picked up by the radio microphone.

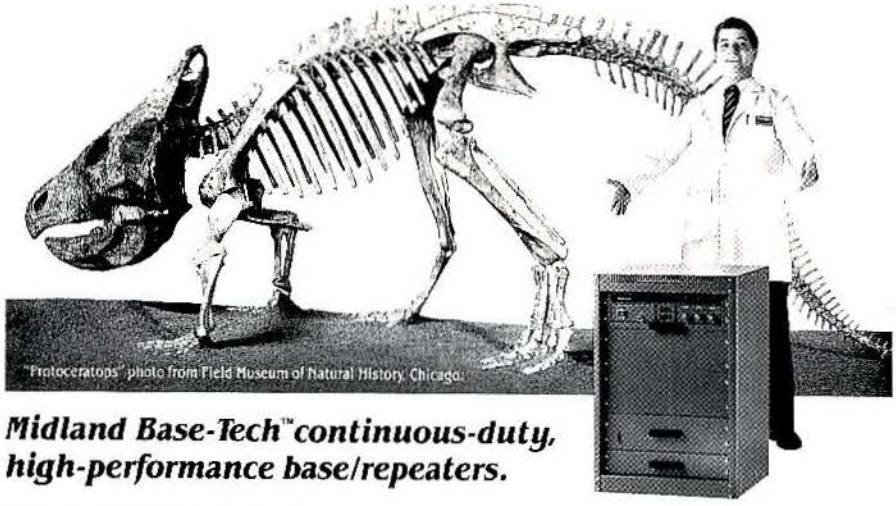
The solution is to reduce the exciter audio gain. (See Figure 5 on page 20.) IDC IC U101's gain is set by R142. Reducing R142's value from 390K to 100K solves the problem. It reduces the audio sensitivity to a point that attenuates most of the diesel engine noise and allows the operator's voice to come through clearly.

Case history No. 5

This case history resembles No. 4, but the radio, a Motorola Maxtrac 300 VHF, is different. The radio is installed on a diesel crawler tractor. The operator complains that, when the engine is running, engine noise overrides his voice. He has to turn off the engine to talk, a real inconvenience.

The problem is verified by listening to a service monitor tuned to the operator's frequency while he uses the radio. His voice is covered completely by engine noise.

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Circle (19) on Fast Fact Card

Normally, it is not advisable to change factory-set component values. Sometimes it must be done to get proper performance in a special situation.

It appears as though the transmitter audio circuitry is too sensitive. (See Figure 6 on page 21.) R568 sets the mic amplifier (U651A) gain. The higher the resistance, the higher the gain.

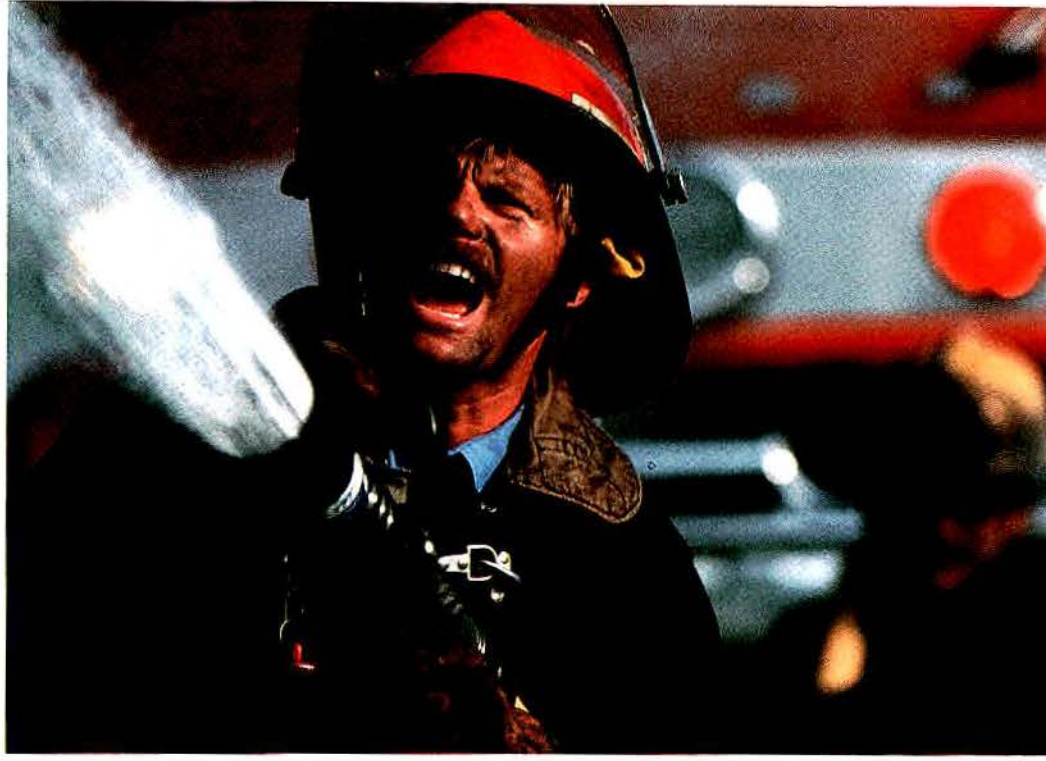
Experimentally, resistance values are substituted for the 620K resistor. It is found that a 120K resistor provides sufficient audio and attenuates engine noise to an acceptable level.

Normally, it is not advisable to change factory-set component values. Sometimes it must be done to get proper performance in a special situation.

It is hoped that these case histories provide the beginner with some insight into troubleshooting land mobile radio equipment. If you really get bogged down on a repair job and all tests seem to lead to a dead end, do not despair. Put the radio aside and go on to another repair job. Come back later to the one you got stuck on and you may be surprised how much better things go when your mind is fresh.

If you use logical troubleshooting techniques and remember what you learn from each troubleshooting experience, you will be performing like an old pro in no time at all.

When every second counts...



Count on the reliability and performance of communications consoles from Orbacom

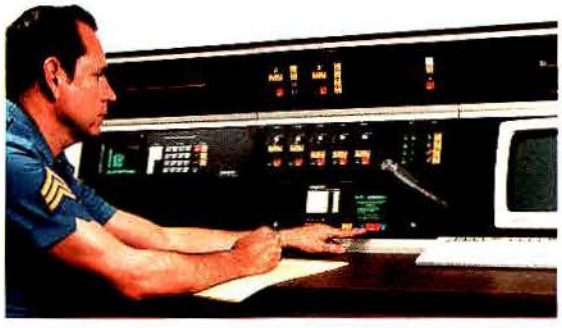
In an emergency, reliable communications are the lifeline for survival. That's why so many communications systems rely on Orbacom's CALIDA and TDM-150 consoles. Their superior performance and solid dependability have been proven in the most demanding applications.

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Circle (20) on Fast Fact Card

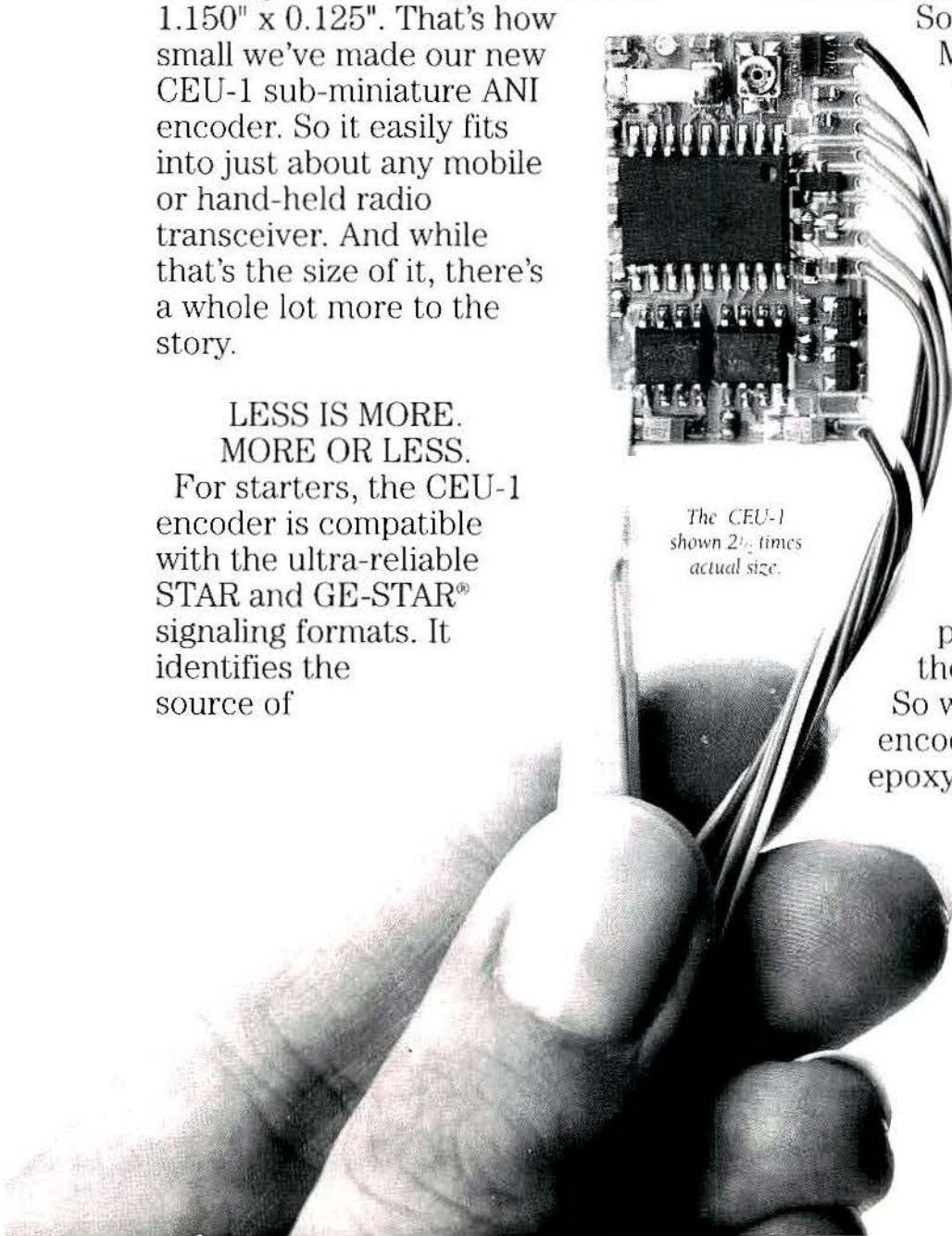
Announcing a ANI technology of in

To be precise, the proportions of this exciting breakthrough are 0.75" x 1.150" x 0.125". That's how small we've made our new CEU-1 sub-miniature ANI encoder. So it easily fits into just about any mobile or hand-held radio transceiver. And while that's the size of it, there's a whole lot more to the story.

LESS IS MORE. MORE OR LESS.

For starters, the CEU-1 encoder is compatible with the ultra-reliable STAR and GE-STAR® signaling formats. It identifies the source of every radio transmission, and also transmits three additional messages. So when there's a "Stuck-Mic," "Emergency" or "Man Down," you'll get the message first time, every time.

Or, if you prefer, program the CEU-1 to provide status or canned messages instead of emergency messages.



The CEU-1 shown 2½ times actual size.

A BETTER ANI ENCODER FOR A LOT OF LITTLE REASONS.

When you make a product as small as this, the little things really count. So we built the CEU-1 encoder using a high-quality, epoxy-glass circuit board and

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AND IT'S ONLY HOW MUCH?

At a list price of only $86, the CEU-1 encoder costs about the same as encoders with a lot less quality and far fewer features.

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Circle (21) on Fast Fact Card

Correct installation for cellular phones

Follow these pointers and tips, and you'll have happy, satisfied customers. Antenna selection depends on where the customer drives. Antenna placement depends on the customer's preference.

By Ronald W. Blizzard

Before drilling holes and routing wire, take time to discuss with the customer where the phone and its antenna will be placed and how they will be mounted. The right choices lead to a proper installation.

Antenna choice

First, ask where the customer drives.

► *Quarterwave antenna*—When he uses the cellular phone, will the customer be in the city, close to cell sites? If so, a quarterwave antenna may be the right choice. Keep in mind that it rarely is the right choice, because few people confine their driving to the city. Used in other areas, the quarterwave antenna tends to cause noisy and dropped calls.

► *3dB gain antenna*—People who drive in city, suburban and rural areas find that the 3dB gain antenna works fine most of the time. Cellular systems are designed to work with 3dB gain mobile antennas.

► *5dB gain antenna*—Where cell sites are widely separated or poorly located, a 5dB gain antenna can help to sustain communications in the fringe areas.

Become reasonably familiar with your area's cellular service area and the conditions in which each customer will be using the mobile telephone. Then you can advise each customer as to the best antenna.

Blizzard is a communications consultant with Communications Engineering, Newport, NJ.

Ten tips for successful installations

1) **Thoroughly check out the vehicle to find any problem areas.**
2) **Decide what antenna is best for the installation.**
3) **Discuss your recommendation with the customer and obtain approval before drilling holes and mounting equipment.**
4) **Make the customer feel comfortable and confident of your ability to do the job right.**
5) **Wear *safety glasses* when working with power tools and in the vicinity of the car battery and wiring.**
6) **When working with the car battery, *use caution* to prevent burns and to avoid damaging the vehicle.**
7) **Treat the vehicle as if it were your own. See that the job is done neatly.**
8) **Return a *clean* vehicle to the customer. Make sure it is free of bits of wire, cut-off tie-wrap ends and other debris.**
9) **Demonstrate proper phone operation to the customer, answer any questions and have the customer place a test call.**
10) **Send the customer on his way, happy and satisfied with the job you have done.**

You probably would not want to cut a hole in your own vehicle, and most customers reject the idea of cutting holes in their cars, too.

Explain the types of antenna mountings and their advantages and disadvantages. Use the store's antenna display.

Brand-name, 3dB gain glass-mount antennas normally are the first choice. Elevated-feed, 3dB gain trunk-mount antennas usually are the second choice, followed by antennas with other gain figures and mounting methods.

Discuss with the customer where to place the handset and the transceiver. Ask whether a console or briefcase will be used together with the telephone and whether children's movements and curiosity should be considered. Take into account the driver's and passengers' safety under normal conditions and if the vehicle were to be involved in an accident.

Other factors governing the handset's position include how easily the driver can reach it; how it affects the driver's

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A. Avoid the use of silicone compound on the connector's plated contact surface.

B. Carefully coat these two areas with a small amount of waterproof silicone compound. This coating prevents moisture from wicking its way into the wire and causing corrosion.

C. Use an insulated crimp connector ring terminal on the battery bolt connection.

D. Insert the wire into the connector to the point where the wire insulation makes contact with the terminal insulation shoulder.

E. Install an in-line fuse holder.

F. Use a vibration-proof locking nut to secure the battery bolt connection.

G. Label and identify all wires and cables with moisture-resistant tags.

H. Insert the line power fuse within 10 inches of the battery terminal. Longer distances may create a fire hazard.

I. Make generous use of nylon tie-wraps, and dress all wiring neatly.

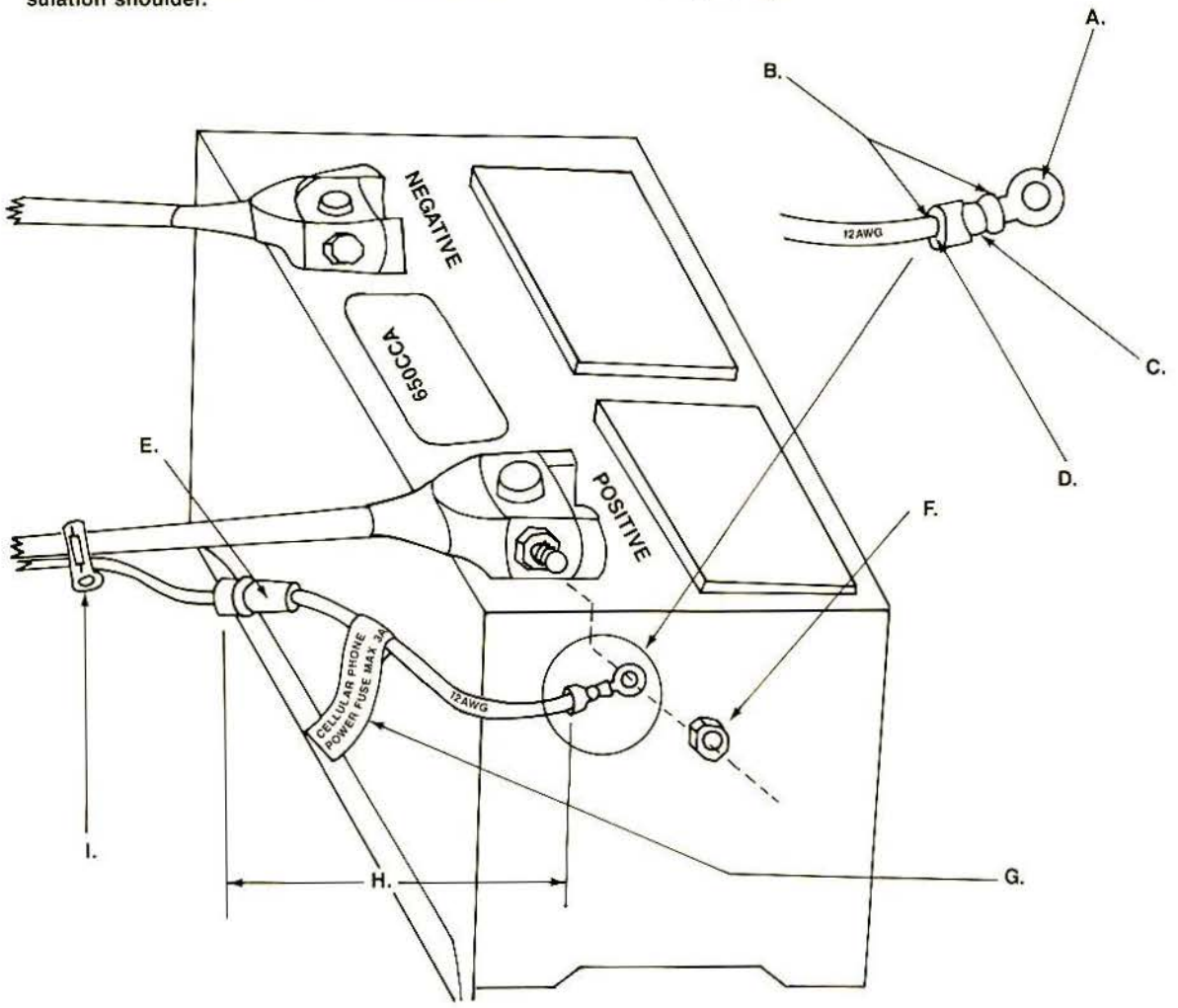


Figure 1. Follow these tips for a long-lasting and neat power connection to the battery.

attention to the road; and how easily it may be serviced.

The transceiver should be positioned so its cables can be routed as far away as possible from the vehicle's on-board computers, alarms, audio equipment, braking systems and any other areas where stray RF may cause a problem. Check with a reputable auto service dealer if there is a potential problem with a certain vehicle and any of its related electronic systems.

Antenna installation

► *Hole-mount*—Before you cut, carefully examine the area for the hole to determine its composition—metal, fiberglass or other material. There is no room for corrections once the hole is cut.

Use a light-pressure, spring-loaded punch to indent the area before drilling or cutting. Never indent the hole with a hammer and center punch. They are likely to dent and otherwise damage a panel or fender, ruining the paint.

Use a sharp drill bit. A dull drill bit may skate across the panel, scratching the paint and nicking the metal surface.

Once you have drilled the guide hole,

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"DACS was designed with customers like us in mind. We started small and built as funds were available. Soon we'll have 14 channels and over 2,600 users on the air. The technical support and effort provided to bring this system on line was extraordinary!"

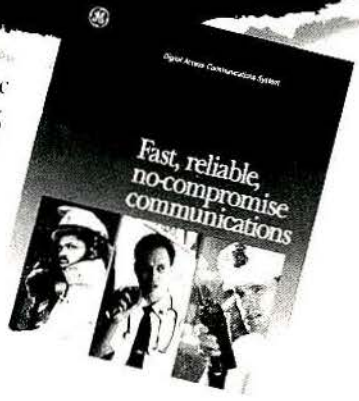
Wayne Gaddy
Director of Construction
Nassau County Department of Public Works
Nassau County, New York

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Carmel Police Department
Carmel, Indiana

"I'm greatly impressed by the failsoft ability of DACS; the fact that the system continually monitors its own operation and in effect 'heals' itself if problems exist. We have complete confidence in it."

Captain Gary Palinkas
City of Parma Police Department
Parma, Ohio



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Mobile Communications

Ericsson GE Mobile Communications Inc.

Circle (23) on Fast Fact Card

use a hand-operated hole punch or a proper antenna hole cutter to finish the hole. If you use a hole cutter, drive it with a ⅓ horsepower variable-speed drill operated at a low-to-medium speed, and use light feed pressure.

► *Glass-mount*—See "How To Install Glass-Mount Antennas" in the November 1988 issue.

Use crimp-on TNC connectors, and apply them with the best ratchet-type crimper your shop can afford. The TNC connector can make or break the cellular phone's day-to-day operation—and your reputation as an installer. Never use a substitute, such as gas-joint pliers or cheap pinch-type tools to attach a crimp-on connector.

Select the best grade of coaxial cable available. Many antennas are supplied with cable. Use the cable that comes with the antenna only if it is well shielded and flexible enough to work with.

Route the cable well away from areas with mechanical damage and where oil and gas may spill. Use nylon cable ties and split loom tubing.

White cable ties should not be used in areas exposed to sunlight because they do not contain ultraviolet light protection.

Keep the wires away from moving parts.

Split loom tubing protects wiring in areas where friction or heat may otherwise damage its insulation. The tubing works well under padding, carpets and mats if it is kept to one side and held securely, away from exposure to direct pressure and chaffing from sharp edges.

Most car manufacturers use plastic cable harnesses that channel most of the vehicular wiring. The cable harness may not be the best location for cellular cables because of stray RF and noise pickup.

When routing wires through the engine firewall and any other holes with sharp edges, protect the wires with silicone rubber grommets inserted into the holes. Keep the wires away from moving parts.

Popular antenna mounting locations

- ☐ *No. 1*—On the window.
- ☐ *No. 2*—On the trunk.
- ☐ *No. 3*—Other locations.

To connect power leads, apply crimp-on terminals with a proper crimping tool. These terminals have a low volt-

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The new Zetron Model 37 RepeaterMan packs so much repeater controller punch, it's kind of like a miniature Zetron Model 38 Repeater Panel, the best selling community repeater tone panel in the world. If you need a low cost, high performance repeater or link controller, all in a tiny package, try a new Zetron Model 37 RepeaterMan!

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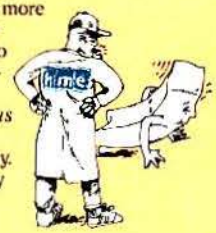
Now virtually everyone can afford to properly maintain NiCad batteries—with HME's new *System 90* chargers and analyzer/conditioners. That's because the System 90's advanced technology costs much less than older analyzer/conditioners.

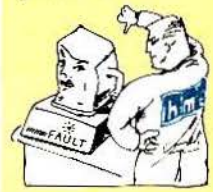
And there's even more good news: HME's advanced technology will cost you a whole lot less until Dec. 15, 1991—take a look at our special offer prices!

HME's *System 90*. It's the big news your batteries have been waiting for.



Keep Your Batteries in Top Condition—Today's NiCads are more predictable, last longer, and charge faster—IF properly conditioned. So don't settle for analyzer-only products. Use the System 90's *microprocessor-controlled IQ plus* stations to Charge, Condition, Analyze and Discharge your battery. An *IQ plus* will do that for as many as 6 batteries, independently and simultaneously—at the lowest prices ever!





Battery Fault Indication—Every HME System 90 model tells you if your battery has particular defects after only 15 minutes! And the comprehensive *IQ plus* combines this feature with an even more thorough diagnostic display.

The Most Thorough Analysis—The System 90's *IQ plus* is an analyzer/conditioner with the most comprehensive digital display in the field. All modes of operation, cycle count, battery fault, voltage and capacity information are *simultaneously* displayed on the LCD information center. HME technology brings you everything you need to know and do—to maintain your NiCads—at the best price ever!



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	6	BC3506P	644	515
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Circle (25) on Fast Fact Card

Antenna choices

- ☐ *Quarterwave*—City driving, close to cell sites. Rarely used.
- ☐ *3dB gain*—City, suburban and rural driving. Most often used.
- ☐ *5dB gain*—Driving in fringe areas with widely separated or poorly located cell sites. Sometimes used.

age drop that can be protected from later deterioration. Seal the connector ends with a waterproof silicone compound that prevents water entry and subsequent corrosion.

If the power leads are to be routed into the engine compartment or elsewhere that heat and oil may be encountered, use flexible, stranded copper with heat- and oil-resistant insulation.

When you connect the power leads to the battery, keep in mind that disconnecting the battery in some cars may cause on-board trip computers and alarm circuits to malfunction or activate. Check before you disconnect the battery if you have any doubt. (See Figure 1 on page 28.)

For a grounding point, use the engine block or the battery's negative terminal. Never trust a grounding point under the dashboard or tapped or bolted onto light sheet-metal body surfaces.

Label all the connecting points and the wires when you install them. Make a sketch of the cable paths and connection locations for later use if service or repair becomes necessary.

Handset installation

Secure the handset mounting hardware with self-tapping sheet-metal screws. They hold well, they speed up the job, and they give a neat appearance. Do not over-tighten the screws or their holding power will decrease.

Use hook-and-loop fabric (Velcro, for example) to secure the transceiver unit in the trunk or under the seat. Keep the transceiver away from power-seat guide rails and areas that may become damp. Put the unit where it can be removed easily for service.

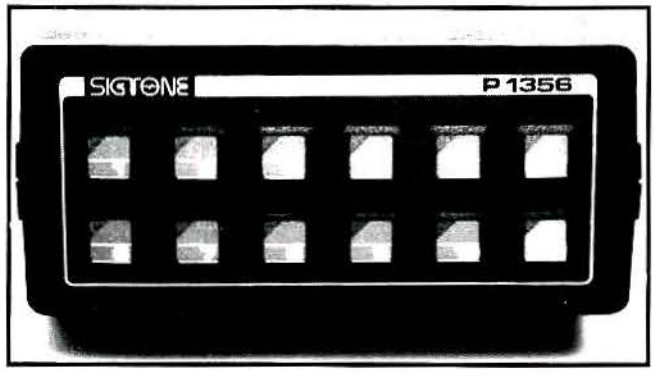
Tough jobs

An experienced technician does not often encounter installation problems that are beyond his skill. But from time to time, more than normal technical expertise may be required. Fortunately, help is available.

Refer to auto repair books with cutaway drawings, wiring circuits and other detailed information. One such source is the Chilton Auto Repair Series.

For really tough problems, such as removing head liners, air conditioners, carpeting and inside trim, visit or call an auto body shop to ask questions before you drill holes and mount parts.

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✓ Identification, status, and selective calling provide the dispatcher with the fleet management tools needed to dramatically improve dispatch efficiency and control.

Other Features
✓ ANI, emergency alarm modes, silent status interrogation, time out timer, horn honk, hidden mic input, and tone blanking are some of the other features available. A P1356 system can be implemented on your existing VHF, UHF, 800/900 MHz conventional or trunked radio system.

Circle (26) on Fast Fact Card

POWER UP . . . with ASTRON.

Astron Corporation is the leading manufacturer of high-quality power supplies and converters for the land mobile industry.

With the new SL-11 series of low profile power supplies, specifically designed for base station applications, the setup is simple, easy and looks attractive. Just mount the radio, with the mounting pads (supplied with the power supply), to the top of the SL-11A (2¾"H x 7⅝"W x 9¾"D) or the SL-11R (2¾"H x 7"W x 9¾"D). The power supplies are very well regulated and will provide 11 amps of current at a 50% duty cycle. The units have fold-back current limiting to protect them from overload and short circuit, and an overvoltage protection feature to protect the radio should the output voltage exceed a safe level. All SL series units are available in dark gray or black.

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Circle (27) on Fast Fact Card

Use an MS-DOS computer to program two-way radios

Many laptop and other small computers are suitable for programming modern two-way radios, and they can be modified so you won't need expensive factory interfaces. Adapter cables can be made inexpensively.

By Richard B. McCreary

Two-way radio shops have an ever-increasing need for the capability to program a wide variety of modern two-way radios. Yet it can cost several hundred dollars to buy a specialized interface module, power supply, PC software and adapter cables to support an individual radio manufacturer's current product line.

Fortunately, there is a low-cost alternative. A fairly universal two-way radio programming system can be made to work with a laptop or "lunch box" type of personal computer (PC). Similarities among various radio models allow the use of common programming equipment.

McCreary is a communications consultant in Columbus, OH.

With most programmable radios, a serial arrangement between the computer and the radio carries the digital programming information. An interface module usually is connected between them. The module contains a simple circuit that transforms EIA voltage levels from the computer to transistor-transistor logic (TTL) voltage levels required by the radio. Although the module may have additional connections that support the radio's operation on the test bench, its basic role is to translate the computer and radio voltages.

EIA voltage levels conform to standards and procedures published by the Electronic Industries Association. The standards and procedures ensure industrywide compatibility for computer equipment. In this case, the standard voltage levels include negative and positive voltages with respect to a common signal ground.

Radio programming interfaces do not normally use EIA voltage levels. Instead, they use the TTL format, which, for all practical purposes, uses two voltages: one is *almost* at ground potential; the other is between 3Vdc and 5.5Vdc.

What may be surprising to learn is that TTL levels are present in the computer. With a little work, the computer's TTL signals can be routed to bypass circuitry that converts them to EIA voltages in the first place to save the cost and inconvenience of the interface module.

Typically, all PCs serial port cards contain the same type of integrated circuits (ICs). The principle IC is a 40-pin universal asynchronous receiver-transmitter (UART), which converts parallel data to serial data and vice-versa. The computer normally works internally in a parallel arrangement while communications in and out of the serial port are carried out a single bit at a time, serial fashion.

When properly buffered, two pins on the UART (normally called "transmit data" and "receive data") provide the communications levels generally needed for a large number of programmable radios. To use the UART for programming radios, the transmit data and receive data pins are wired to a 14-pin IC, which in turn is used to modify a serial card to do double duty: to carry out its normal function and to carry programming information between the computer and the radio. The modified serial card per-

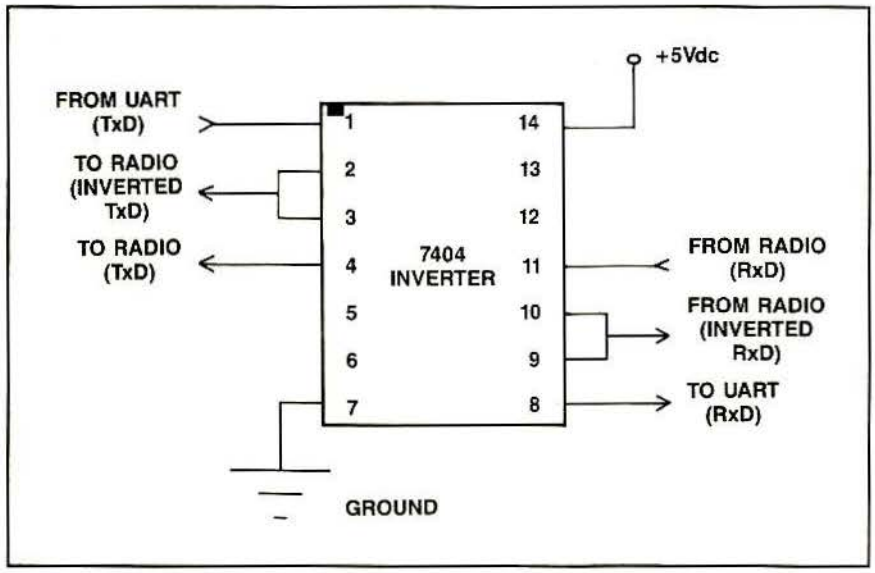
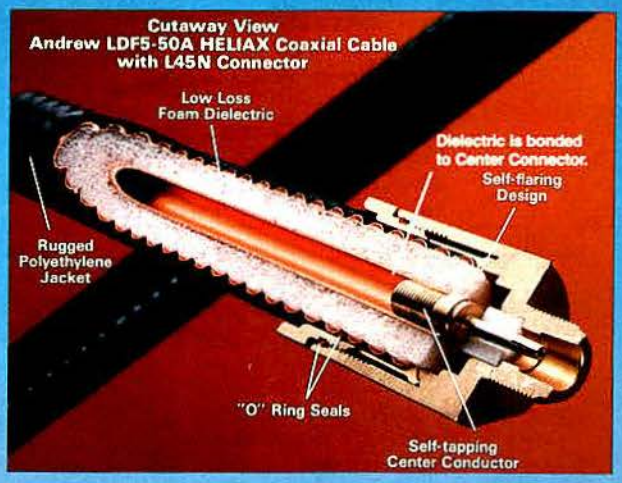


Figure 1. Modify a personal computer's serial card with a 7404 inverter as shown to provide logic levels for programming two-way radios.







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Decibel antennas pictured (L to R) are DB408, DB859, DB559

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Circle (28) on Fast Fact Card

forms in its original configuration as though it had not been modified.

Some two-way radios require an inverted signal level instead of the standard logic levels some manufacturers use. The signal can be inverted by the IC.

The IC used for this application is a 7404 series Hex Inverter. "Hex" means the chip contains six inverter buffers. Figure 1 on page 34 shows how to wire the inverter IC.

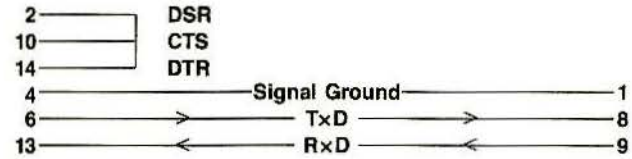
TYPICAL INTERFACE CABLE PINOUTS

The pinouts used on a 15 pin game port connector of a serial port card: ($20 to $30 from any number of mail order suppliers)

2	Data Set Ready (DSR)
3	Not RxD
4	Signal Ground
6	TxD
10	Clear To Send (CTS)
11	Not TxD
13	RxD
14	Data Terminal Ready (DTR)

(Homemade) General Electric Model MVS & TMX 8825 series

15 Pin Male Connector to CPU **10 Pin Connector to Radio**



Continued on page 38

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Continued from page 36

ADAPTER CABLE WHEN GE FACTORY CABLE IS USED

25 Pin Male Connector to GE Cable **15 Pin Male to CPU**

11	RxD	13
12	TxD	6
25	Signal Ground	4
17		2
13		10
		14

(Homemade) General Electric Model TMX 8712 series

15 Pin Male Connector to CPU **9 Pin Connector to Radio**

4	Signal Ground	8
6	TxD	1
13	RxD	6

(Miscellaneous Adapter—25 pin to 9 pin for /AT serial ports)

9 pin	25 pin	9 pin	25 pin
1	8	6	6
2	3	7	4
3	2	8	5
4	20	9	22
5	7		

General Electric Model MLS series (Factory Cable)

25 Pin Female Connector **8 Pin Female Molex**

13	(Gnds. CTS)	
9		
6	A+	1 (8)*
12	TxD	7 (2)*
11	RxD	2 (7)*
25	Signal Ground	4 (5)*

***Could be either set of pin numbers depending upon radio's pinout labeling.**

(Homemade) Fujitsu FTP15/45-554AT Portable series

15 Pin Connector to CPU **Dual Phone Plugs to Radio**

4	Signal Ground	1 (Ring either plug)
6	TxD	2 Tip of small plug
13	RxD	3 Sleeve of large plug

Two of the inverters are wired in series in each line of the serial pathways: the receive data line has two inverters wired in series with it *from* the output connector; the transmit data line has two inverters wired in series *to* the output connector.

A 15-pin game port connector may be adapted for this application. A game port connector is not often used in a business application, but it is found on most serial input-output (I/O) cards. If a game port connector is not available, any connector on the card can be used, provided it has at least five spare unused pins.

The five connections are all that are required to bring all the logic levels to the outside connector that a technician is likely to need.

Two leads are attached *between* the series inverters. They provide an inverted logic level from or to each logic line.

Two leads are attached before or after both inverters to provide isolation and normal (non-inverted) logic levels.

The fifth lead—the signal ground—is the common signal return path. It usually is the logic ground, and it can be found at pin 7 on most 14-pin digital

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ICs and at pin 8 on most 16-pin digital ICs.

It is feasible to install the IC directly on top of another 14-pin IC by soldering pins 7 and 14 to the existing chip. Bend the remaining leads upward and attach the additional leads to them. Use small "wire wrap" wire of A.W.G. No. 30 or similar size for the connections to other points from the inverter IC.

After modifying the serial card, fabricate adapter cables to connect to each brand and model of radio to be programmed. Manufactured cables cost $50 or more apiece, so it is worth making your own for $5 worth of materials and 15 minutes of labor. Refer to each manufacturer's literature and the diagrams included within this article for the wiring details of some of the cables previously built and tested.

Follow each manufacturer's instructions for installing the software into the computer. The software should allow the programming information to be addressed to either the COM1 or COM2 serial ports on the serial card, one of which you will have configured for the programming task.

Connect the radio, attach the necessary cables, and you are ready to program. This programming capability especially will be helpful if you need to reprogram a customer's fleet in the field or if you have to equip a number of service technicians with similar hardware.

Most of the equipment is neatly packaged in the computer. The rest of the equipment consists of the portable computer and adapter cables, along with the normal complement of two-way radio tools and test equipment.

Cost comparison

To reveal the difference between buying factory programming equipment and making your own, list the different radio products you service. Then calculate the factory cost for the software, the interface adapter and cables for each radio, and total the list.

If your list includes more than four models of radios, the factory cost may shock you. It may remind you of a similar cost comparison from the days when, for $2,000 to $4,000, manufacturers sold a briefcase containing no more than a miniature computer and a simple printer.

Next, liberally estimate the costs for a few feet of shielded intercom cable (some call it data cable), a few 15-pin or 25-pin connectors and the special connector that attaches to the radio. Add the estimated value of your bench time. Be reasonable. Remember, this work is going to be done *after hours*, is it not?

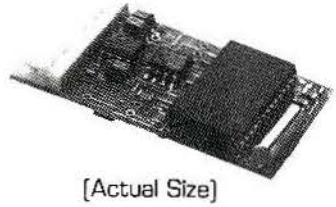
Even if you must buy the parts at retail, the cost advantage is significant, and the gap increases when you multiply the number of components required to outfit every field technician you want to equip.

The manufacturer's software program is copyrighted, so you should purchase a legal copy for each technician you equip. The hardware can be fabricated in the shop at sufficient cost savings to make the overall expenditures more reasonable.

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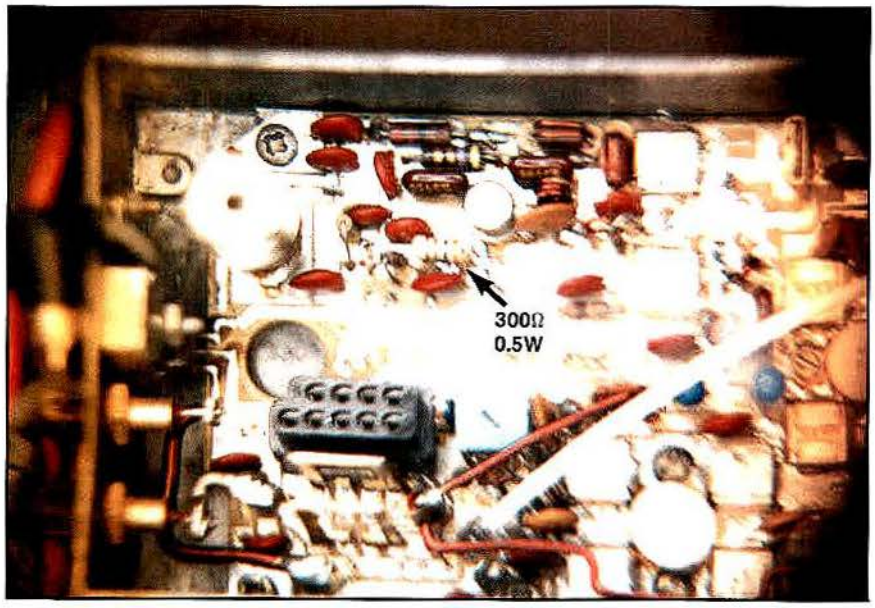
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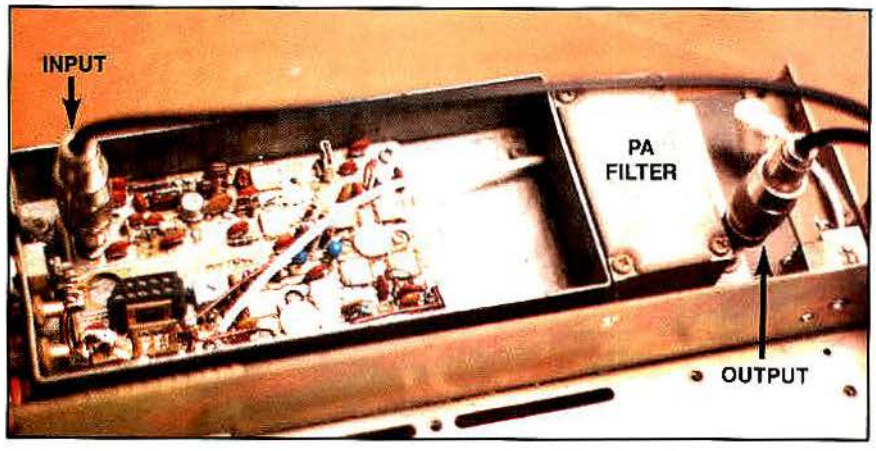
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RF amplifier deck boosts service monitor output

Part 1—Changing the swamping resistor in a GE Mastr Executive II transceiver's RF amplifier deck adapts the amplifier for use with low-level service monitor outputs. Outputs as high as 25W have been achieved.



A 300Ω, 0.5W resistor, shown near the driver transistor, is all that is required to modify the RF deck so it can amplify a service monitor signal in the milliwatt range to an output of tens of watts.



RF from the service monitor is fed to the RF deck through high-grade, low-loss coaxial cable. Odd-integer multiples of quarter-wavelengths of coax must be avoided for maximum performance. RF output is taken through the PA assembly's filter.

By David Ludvigson

"Blast—I wish this service monitor had some *power* to it!"

I do not know how often that phrase has echoed down CECO's halls, but as a technician, I know that although we have accurate, synthesized test equipment, seldom does it have enough output power even to access nearby repeaters.

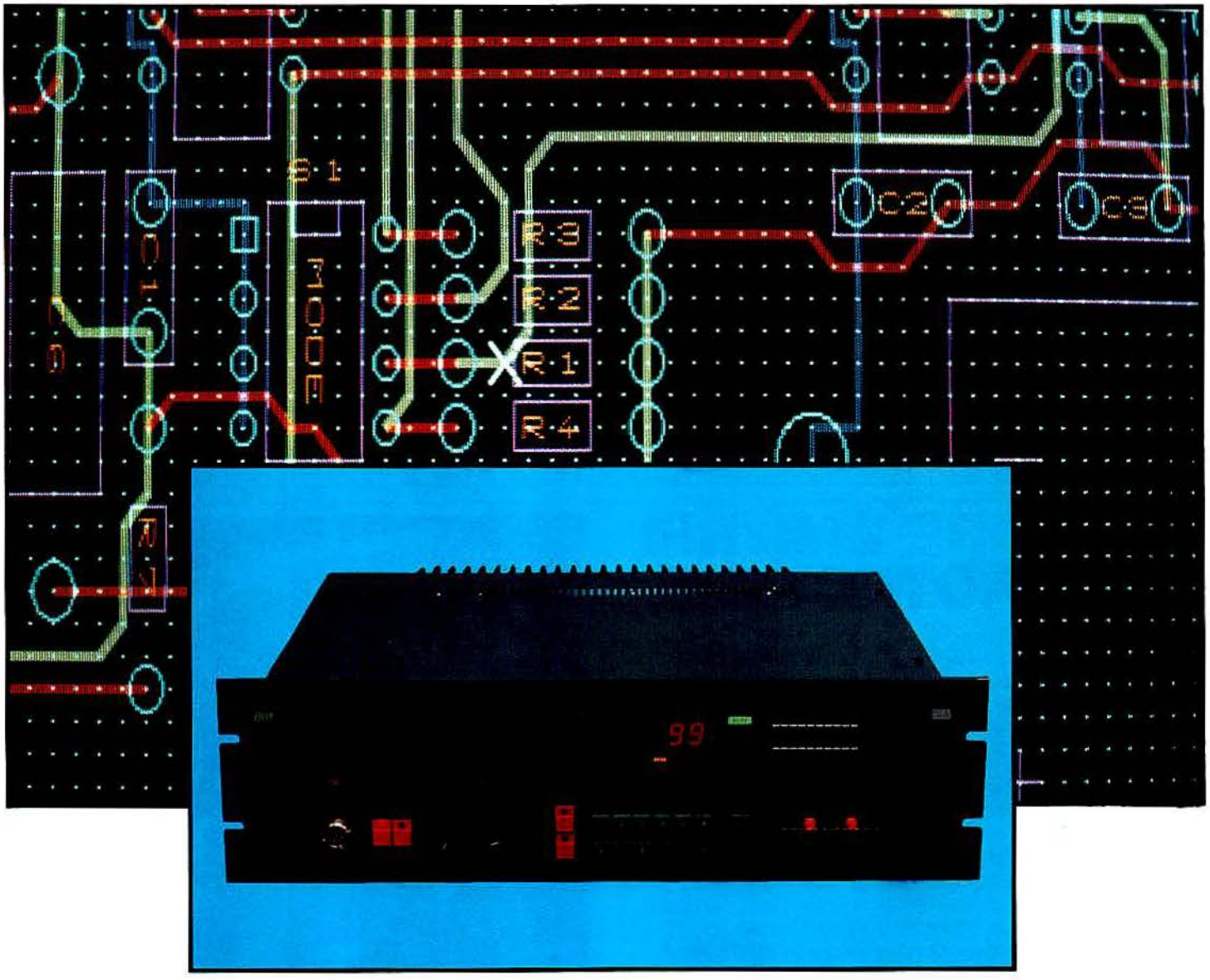
After repairing numerous Mastr Executive II transceivers suffering from defective power amplifiers, it occurred to me that such a power amplifier would be a useful addition to any signal generator. The transceiver's power amplifier is relatively small, its layout is adequate for servicing, and its heat sink is sufficient for its 40W rating.

Full output from Cushman and Motorola service monitors is not enough to drive the amplifier. Some time spent studying the GE LBI30061 service manual revealed that the amplifier's 27Ω base-to-ground swamping resistor is too small. Increasing the resistor R215 value to 100Ω brings the output level to 8W when the amplifier is driven by a Cushman CE-4's full output. Increasing R215 to 330Ω brings the output above 20W. To maintain RF stability, the resistance should not be increased any further.

After the amplifier was tested by driving it with the Cushman monitor, it was connected to a Motorola 2000-series generator. With a 1Vrms signal at the amplifier input, output reached 25W with a 14V source voltage and a 6A current.

Ludvigson is a technician with CECO, Houston.

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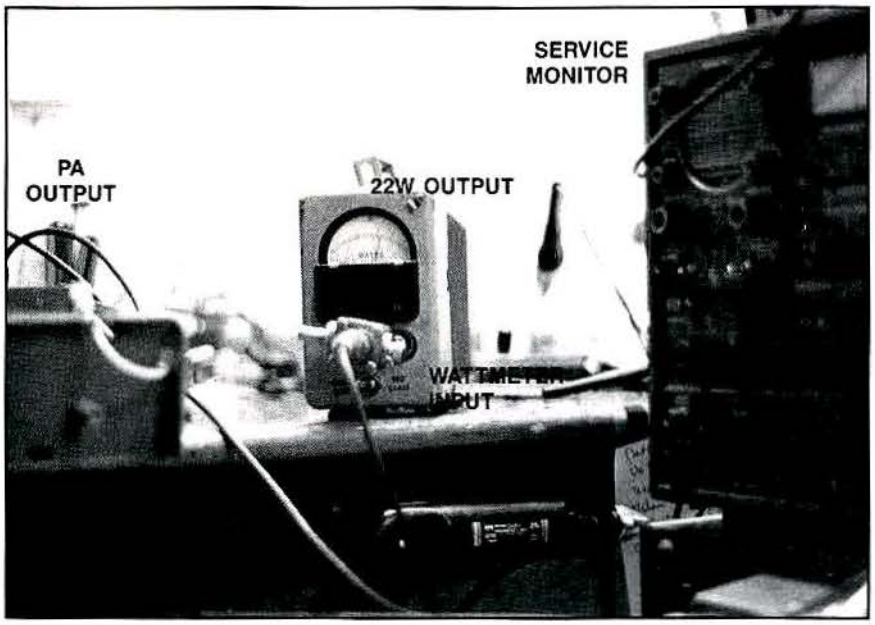
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In this test setup, a Cushman CE-4 drives the amplifier deck directly. RF power output is indicated on the terminated wattmeter.

Several versions of this amplifier are available for covering individual ranges from 400MHz to 512MHz. Capacitance and inductance values have been optimized for maximum output across about 20MHz of the UHF band. To keep the output clean, especially when driving the amplifier with older Cushman monitors, the output bandpass filters are left in place. RCA-to-SO 239 adapters work well for carrying RF in and out of the amplifier deck.

Hardware

General Electric no longer makes the Executive II RF deck, so scrounging may be necessary. It is better if the entire transceiver works, but the following steps take the experienced technician through the tune-up procedure necessary to build the "boot" for a signal generator.

A crystal oscillator, followed by a ×36 multiplier deck, sets the Executive II's output frequency. For lack of the actual test fixture for aligning these stages, a simple RF probe and voltmeter usually are adequate. Probe each stage's collector as you tune the base for maximum RF as measured by the voltmeter. Most of the multiplier stage transistors have a metal case connected to the collector, making it fairly simple to find a suita-

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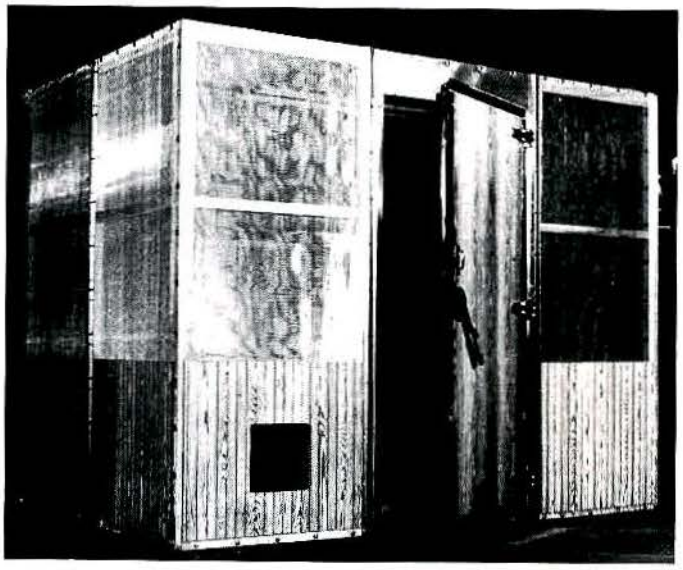
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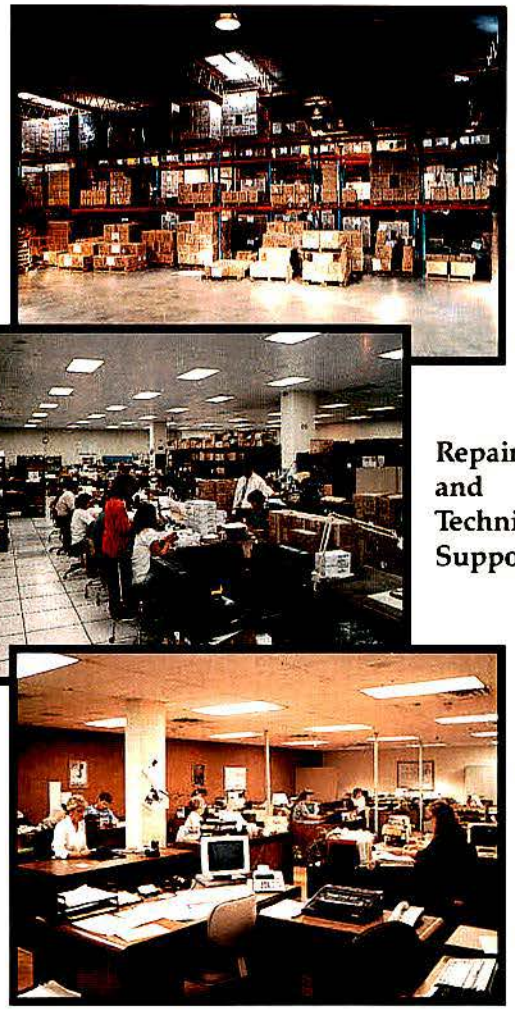
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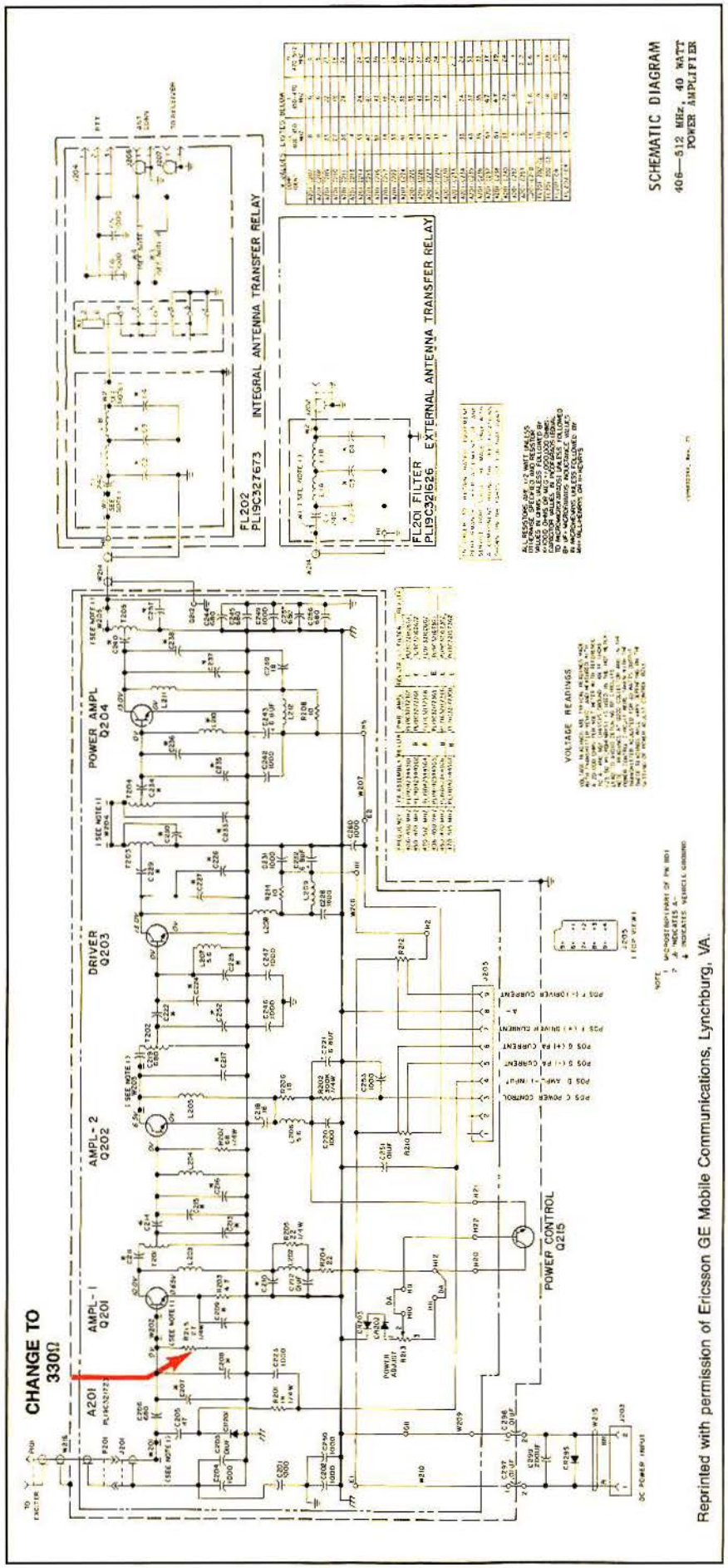
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ble test point. As you key the transmitter, align each successive stage for maximum RF.

By the time you reach the PA deck, there should be enough RF output to be detected by a monitor tuned to the operating frequency. If the output reads about 25W to 40W, no further adjustment should be required. Disconnect the driver stage at the RCA jack, replace the 27Ω resistor with a 330Ω resistor, and connect the working PA to the signal generator.

Defective RF deck

Chances are, though, the RF deck will be defective.

Troubleshooting the RF deck requires the RF probe and voltmeter combination. Probe the collector of Q201; it should give a fairly strong reading of the input signal. Q201 has a metal case that makes it easy to read the collector signal.

Probe the base of Q202, and you will measure a drop in relative signal strength. The test point has a low input impedance that causes a drop in RF voltage.

Measure the voltage at the Q202 collector. You should read a fairly strong signal. If not, switch to dc readings and see whether the voltage regulator delivers at least 9V to Q202's collector network. The failure of Q202, the voltage regulator Q215 or both have accounted for most of the repairs made to date. Q203 and Q204 have been completely reliable in a dozen or more repairs made to these decks.

Replacing Q202

If Q202 must be replaced, take care that the spring washer is placed between the body of the transistor and the heat sink case. Tightening the securing nut without the washer breaks the transistor body and short-circuits its internal leads.

When the regulator-pass transistor Q215 fails, the trimpot R213 used to adjust output power is subject to failure. Intermittent swiper contact seems to be the cause of R213 failures.

Simple wear and tear of the RF decks

Change resistor R15 to 330Ω to raise the amplifier output above 20W.



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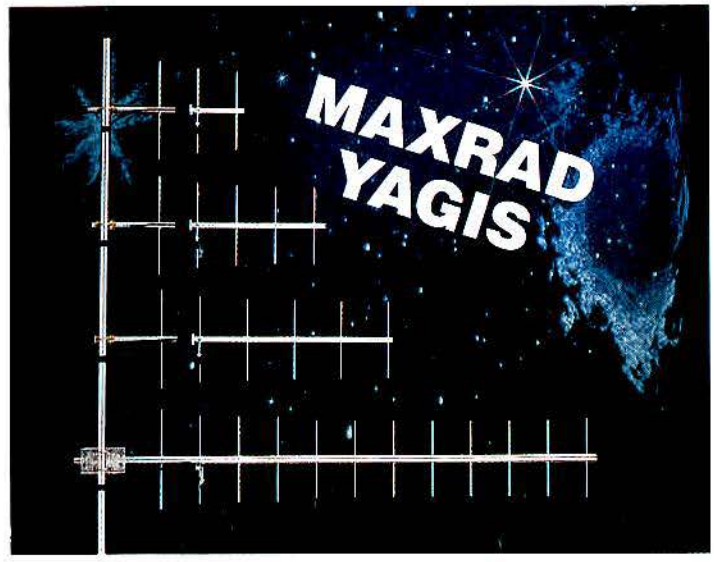
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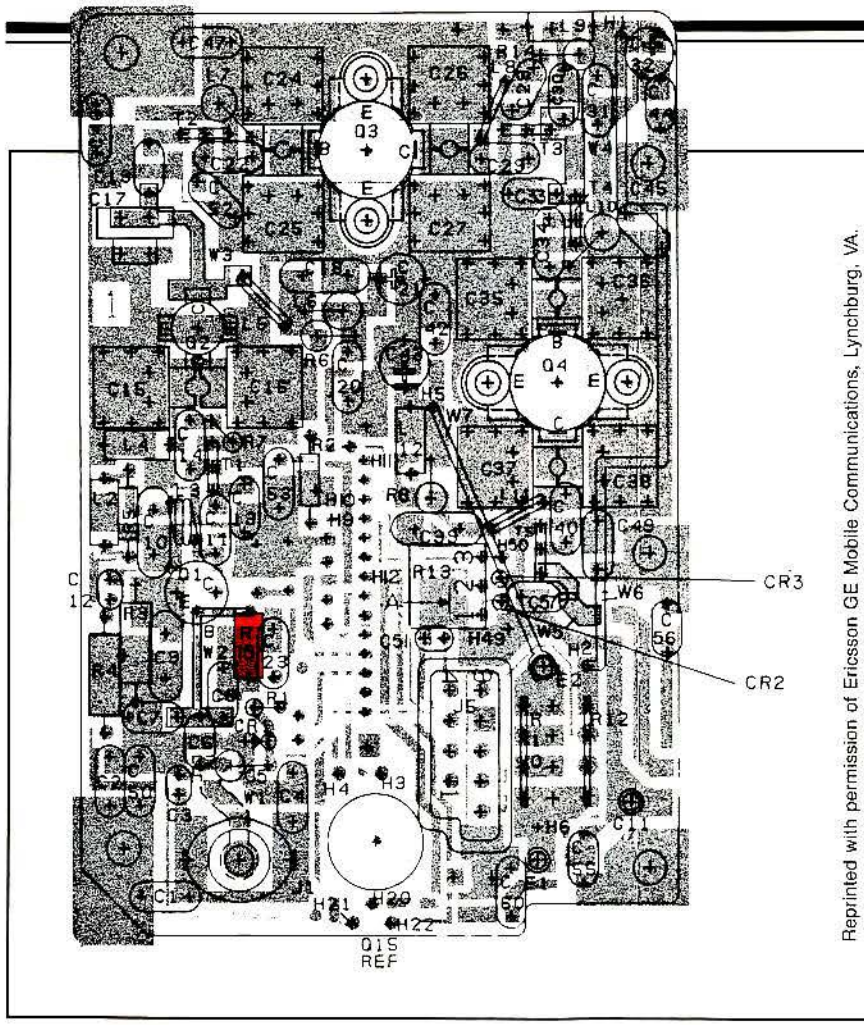
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Use this reproduction of the parts layout plan as a guide to find resistor R15, which is highlighted in red.

may be found. Dirt, mud and corrosion are all too common. To clean the deck, remove the circuit board from the housing, wash it in circuit board cleaner (Flux-Off cleaner, for example), brush it down with a toothbrush and dry it off with a controlled airstream. The foil on some boards is dark with oxides and coated with corrosion. Diligent application of circuit board cleaner usually pays off.

Technical considerations

Once the RF PA deck is working, it is time to configure the connection to the signal generator.

The deck cannot amplify low-level RF, so there is little need for an on-off switch. With Cushman generators, it is convenient simply to patch into the "high level" output jack and set the amplifier's RF power output to a suitable level using the signal generator's variable attenuator.

Additional modifications

Removing the combination amplifier and heat sink module from the Executive II allows construction of a multi-deck, wideband PA assembly. RF input and output wiring can be done via remote relays as 13.8V is applied to each amplifier individually.

A modification that may be valuable to many users involves the installation of a TR switch at the antenna jack. The TR switch is configured to allow an RF pre-amplifier to be used during reception.

Inventive minds undoubtedly will find other possible refinements.

As with any other amplifier, the Executive II RF deck is capable of boosting only what is fed to its input. Speech modulation; continuous-tone coded squelch system (CTCSS) tones; dual-tone, multiple-frequency (DTMF) tones or whatever your test gear can generate still is available; but the use of the amplifier extends your test gear's reach by several miles.

Next: How to use the Executive II as a tunable UHF receiver.

Acknowledgements

The author extends his appreciation to:

1. Ken Carlson and the extended family of CECO at Houston, Dallas and other locations.
2. Charles Ashley, who patiently suffered the author's mutterings and musings and who provided the photographs.
3. Carl Sensabaugh, manager of technical publications at Ericsson GE Mobile Communications, Lynchburg, VA, for permission to reprint schematic diagrams.

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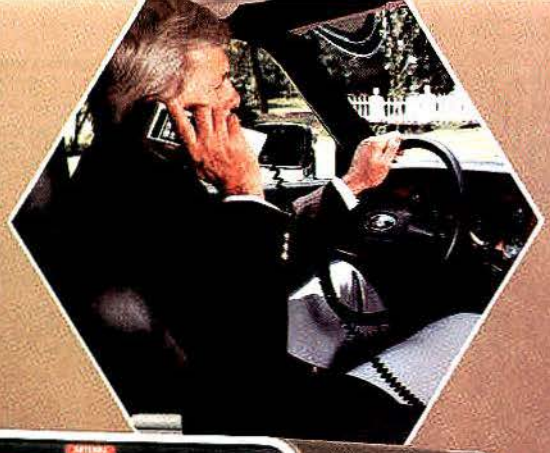
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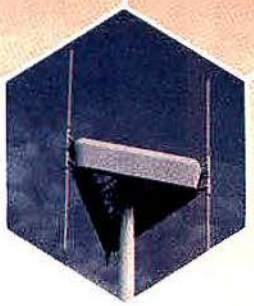
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NCMO modulated oscillator allows high-speed paging

Boost paging system capacity by increasing the speed at which messages are transmitted. High-speed transmitters and pagers can eliminate the need to add a channel. Speeds in excess of 4,800 baud can be achieved.

By Rafael Garcia

The number of radiopager customers is growing so fast that large radio common carriers (RCCs) are running out of capacity. Public demand for alphanumeric paging goes unfulfilled in some areas because not enough airtime is available to carry the longer messages. (Alphanumeric messages include letters along with numbers to spell out written information.)

RCCs with multiple transmitter sites face an enormous capital expense if they must add independent channels when all the airtime on their existing system is consumed. Adding an independent channel may require a minimum of one additional transmitter at each site and might require building new sites.

Another solution is to increase the rate at which paging messages are sent. If more messages can be sent in a given amount of airtime, system capacity is increased.

Increasing the paging rate does not come without cost: New pagers or new transmitters or some combination may be required.

Most digital pagers in the United States operate at 512 baud; some operate at 1,200 baud. A company in England is said to be developing pagers that receive messages at 2,400 baud.

These pager improvements promise RCCs a doubling and tripling of capacity, provided their transmitters function at the higher baud rates. Eventually, baud rates of 9,600 or more are possible, although current bandwidth regulations do not permit such a high speed. For example, the European Radio Message System (ERMES) signaling system will operate at 6,250 baud. It is under development. Preliminary service is expected to begin by the end of 1992.

Transmitters capable of such high speeds have been difficult to build because electronic components in common use tend to distort high-speed paging messages too much. A solution to the transmitter design problem has been found in the use of a high-stability, numerically controlled, modulated oscillator (NCMO) together with frequency upconversion.

This technology can be implemented in existing transmitters by installing a new exciter. The NCMO high-speed digital module is designed to replace existing analog-only (voice) and low-speed, 300-baud-to-1,200-baud digital exciters.

Two factors affect this use of NCMO technology.

First, numerically controlled oscillators at present have a usable frequency response of less than 40MHz. They are not readily usable at paging transmitter frequencies in the 150MHz, 450MHz and 900MHz bands. Thus, the NCMO output frequency must be raised to the desired frequency band.

Frequency multipliers commonly are used to increase oscillator output frequency, but they have the drawback of

Garcia is president of Teletrol, Miami. He has applied for a patent on the transmitter design described in this article.

Abbreviations:

DAC—digital-to-analog converter.

FSK—frequency-shift keying.

IEM—independent endpoint modulator.

NCMO—numerically controlled, modulated oscillator.

PLL—phase-locked loop.

RCC—radio common carrier. At one time, RCCs included all FCC common carrier mobile telephone and radiopaging licensees not affiliated with wireline telephone companies. Modern use of the term tends to refer only to common carrier *radiopaging* licensees (including wireline telco affiliates) and to exclude cellular and other common carrier mobile telephone licensees.

VCO—voltage-controlled oscillator.

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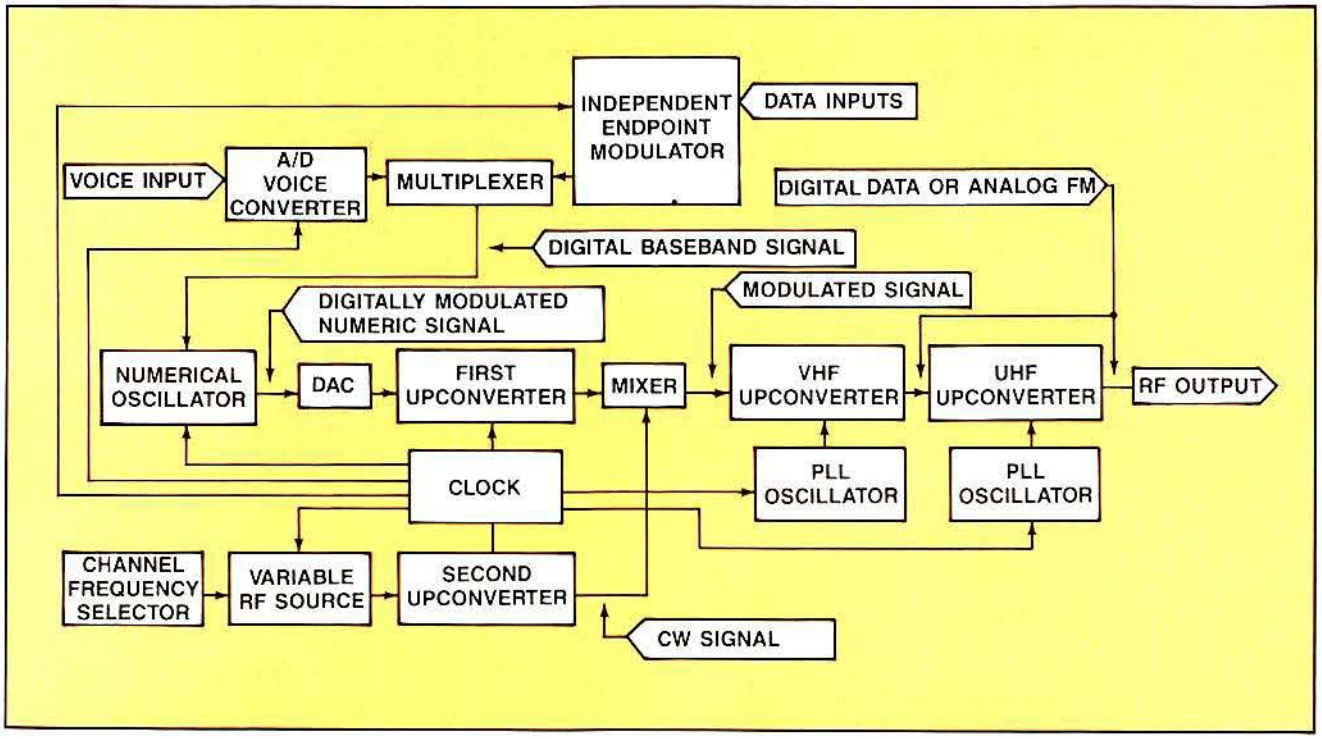
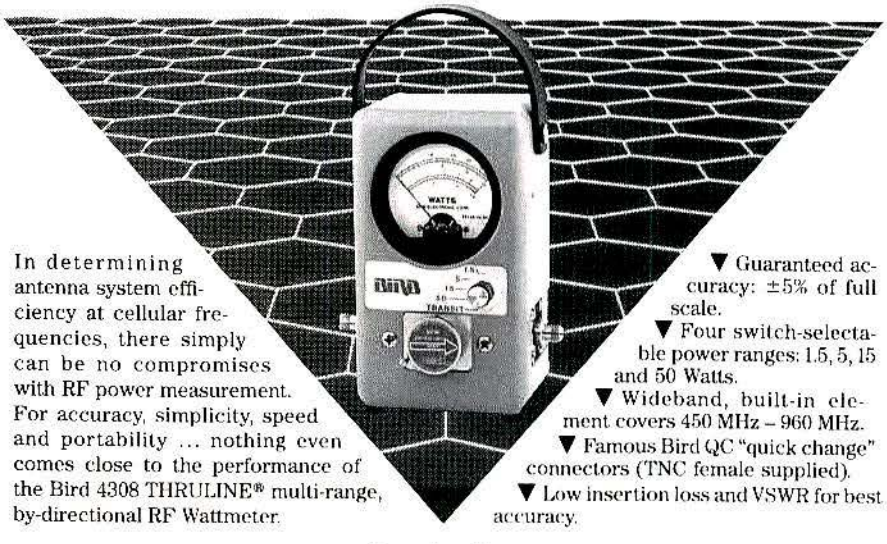


Figure 1. The paging transmitter includes a digital and analog modulator that handles frequency-shift keying (FSK) digital data, as well as analog information in the form of audio tones and voice.

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multiplying the deviation of an FM signal. Distortion and noise introduced by conventional frequency multiplication limit the signal quality (signal-to-noise ratio) because of the initial low-level modulation deviation required.

Another method, upconversion, uses a mixer and a local oscillator to boost the numerically controlled oscillator's frequency to the desired output frequency without affecting the deviation and with much less distortion.

Second, modulating the numerically controlled oscillator allows the frequency to be modulated digitally. Synthesizers are not involved in the modulation process, so they do not affect the quality of the output information (data). Synthesizers are microphonic, meaning vibration and other mechanical movement can modulate their output. Removing them from the modulation process increases stability and reduces distortion.

Figure 1 above shows a block diagram of the paging transmitter. It includes a digital and analog modulator that handles frequency-shift keying (FSK) digital data, as well as analog information in the form of audio tones and voice. It is capable of transmitting paging mes-

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sages at speeds in excess of 4,800 baud in the 150MHz, 450MHz and 900MHz bands, increasing by threefold the capacity of many present systems.

The circuitry can be described as forming eight basic blocks:

- ☐ modulation controller.
- ☐ RF modulator.
- ☐ tuning synthesizer.
- ☐ baseband converter.
- ☐ VHF upconversion.
- ☐ UHF upconversion.
- ☐ reference frequency.
- ☐ RF power amplifier.

'Digital' voice modulation

Although voice modulation is analog, voice input to the transmitter is digitized for processing and then reconverted to analog form.

Voice modulation is zero-centered on the carrier. This means that when the transmitter is set for voice modulation, the carrier stays on the center of the channel until a voice waveform created by the numerically controlled, modulated oscillator (NCMO) is present. Then the voice waveform frequency-modulates the carrier symmetrically around the channel center. Voice modulation distortion is less than 1% because of the digital process' inherent linearity.

Digitally implemented voice modulation can make overdeviation impossible. The analog-to-digital (A/D) converter produces an output consisting of numbers between zero and a predetermined limit. These numbers represent all the available modulator input. When the numeric modulator is set to not overdeviate the transmitter with full-scale numbers from the A/D converter, overdeviation is impossible.

Data modulation

Fully numeric data modulation has advantages. Without the use of phase-locked loops (PLLs), complex dc restoration, switched multiple loops, skewed crystal references and other means to keep the carrier frequency accurate during modulation by asymmetrical data, waveforms are unnecessary. The numeric modulator keeps full station reference frequency accuracy at all times and at all output frequencies.

Because the output signal accuracy is independent of all output modulated waveforms created by the NCMO, other capabilities are realized.

In particular, positive and negative carrier deviations are completely independent of each other. Switches set the positive deviation from zero to 5kHz with better than ±10Hz resolution. Another set of switches sets the negative frequency deviation over the same range and resolution. Digital controls allow frequency and modulation settings to be adjusted remotely.

Endpoint modulator

The independent endpoint modulator (IEM) controls the rate at which the RF carrier output switches from one deviation endpoint to another. This control slows the deviation switching rate to reduce spectrum occupancy when necessary. At full speed, the IEM sup-

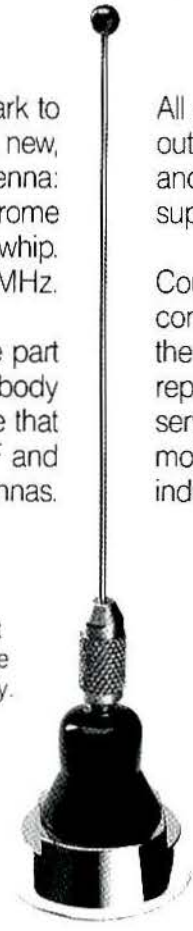
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UHF Transmit Power: 25 Watts

VHF Frequency Separation: 15 MHz

UHF Frequency Separation: 20 MHz

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8 Channels

MIL-STD Spec 810 C&D Certified

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Scan—Not Available On This Model

Time-Out Timer

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UHF Transmit Power: 25 Watts

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ports a rate much higher than 4,800 baud with less than 8kHz of FSK deviation.

The PLL-generated frequencies add to the final frequency range, so they are relatively independent of the modulation. What happens with one set of PLL-generated frequencies directly affects the output, but it has no effect on any of the other PLL-generated frequencies. This independence is a major reason why the transmitter can be digitally modulated at such a high baud rate on the VHF and UHF spectrum.

Upconverters

The PLL in the VHF and UHF upconverters are independent of any and all modulation developed by the RF modulator. The PLL is independent of the tuning synthesizer that sets the transmitter's tuning resolution.

Thus, the PLL can be independently optimized for low noise without compromising the output tuning resolution requirements or linearity and bandwidth requirements for accurate modulation. The upconverting technique eliminates the undesirable noise and modulation (microphonics) usually associated with PLL devices and their voltage-controlled oscillators (VCOs).

Transmitter output always is a direct multiple of the station clock oscillator reference. As a result, the transmitter design is completely locked to the station clock reference, which controls the station's long-term stability. The use of a single, high-stability clock oscillator for all modules ensures that there is no tendency for unrelated drift.

The PLL is independent of the tuning synthesizer...

The A/D voice converter takes the audio signal from a microphone or audio line connected at its input, amplifies it, digitizes it and synchronizes it to the system clock. The resulting output is fed to the multiplexer.

Preset switches on the IEM independently control the FSK signal's positive and negative deviation limits. IEM output combines with digitized voice from the voice converter.

The data-voice selector determines whether the voice or the FSK signal is sent to the numerically controlled, modulated oscillator's modulator port. At this point, a DAC is available to test the IEM.

The NCMO converts the numeric modulation it receives from the multiplexer and digitally synthesizes a properly modulated lowband RF signal. The DAC then converts the digitally modulated numeric signal to a modulated RF signal in an analog form. The DAC waveform is low-pass filtered to remove all sampling mixing products. This modulated sine wave is upconverted with the clock reference frequency and filtered again to yield the sum component.

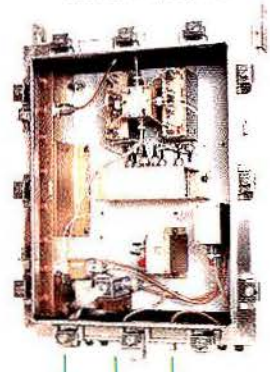
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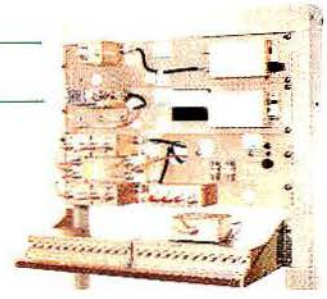
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The variable RF source synthesizer does not use a PLL. It is another numeric synthesizer operating from the station clock reference, using the numeric synthesis technique that provides fine resolution with no degradation in phase noise from the reference signal.

Programmable switches set the tuning of the transmitter output signal over a predetermined range. This unmodulated RF signal is low-pass filtered and upconverted (mixed) with the clock reference, filtered again and upconverted with the NCMO's modulated signal to select the sum component. The result is a modulated signal between 25MHz and 26MHz. The baseband combiner provides an output signal that is properly modulated and tunable over a preset bandwidth.

The VHF upconverter block synthesizes a fixed VHF local oscillator using a PLL and upconverter. The upconverter combines the local oscillator signal with baseband signals to provide the RF output frequency in the 150MHz-to-174MHz band. A bandpass filter conditions the VHF RF output somewhere between 150MHz and 174MHz.

A PLL forms the circuitry for the 127MHz local oscillator. The VCO is a simple Colpitts oscillator. Output isolation is achieved with a wideband amplifier.

The buffered VCO output is sufficient to drive a diode ring mixer to perform the upconversion. Mixing the VCO output with the RF baseband and bandpass filtering the sum component yields the desired output frequency.

When the transmitter is configured to use the UHF frequency ranges of 450MHz or 900MHz, an additional upconversion circuit is used. This UHF upconverter circuit, in principle, is similar to the circuit on the VHF upconversion module.

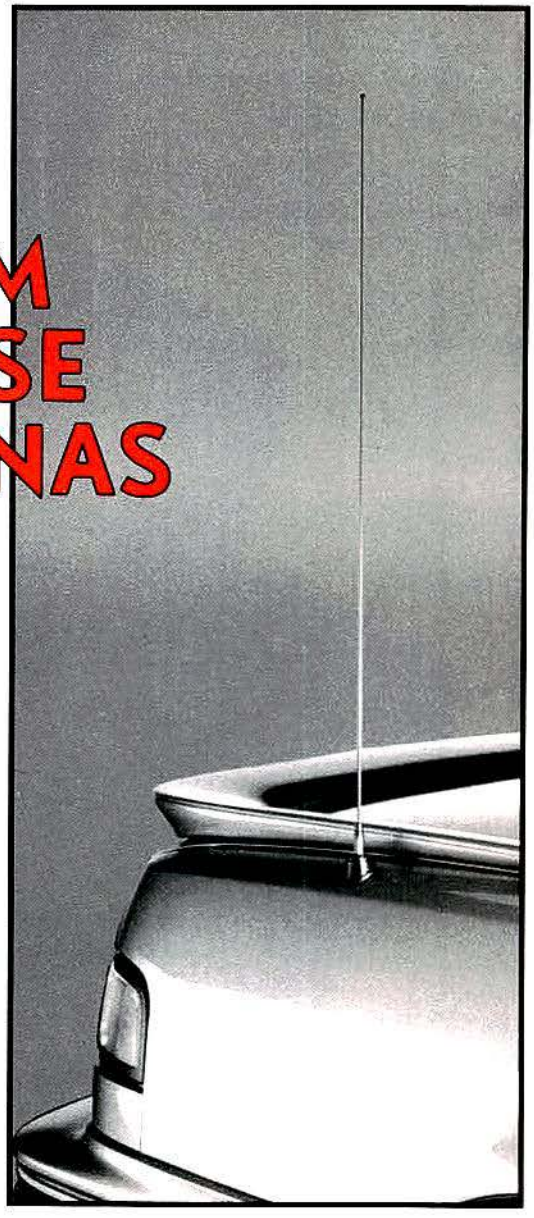
The UHF upconversion block synthesizes a fixed, 302MHz local oscillator using a PLL and mixes the combined baseband with it to provide the final transmitter output frequency for the 450MHz-to-470MHz band. A fixed frequency of 779MHz is used for the 931MHz-to-932MHz band.

Reference frequency

The reference frequency block provides for distribution of the 10.000000MHz high-stability station reference to the entire transmitter. There are eight places where this reference is used.

A buffered sine wave is distributed among the blocks. A square wave conversion is done internally at each module, as required, to avoid transmitting a wideband square wave within the transmitter, which otherwise might be radiated as spurious emissions. Wideband square waves are generated and used only within enclosed modules where they are more easily controlled.

The advantage of using a single, high-stability clock reference oscillator with a common frequency for all the modules achieves simplicity and economical design.



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Canned messages help users to profit from alpha paging

Canned messages help paging carriers to reduce airtime consumed by alphanumeric paging. Users send canned messages more easily, making alpha paging more practical and attractive to new customers.

By Jim Marion and Rick Wilson

Rapidly decreasing equipment prices and service fees for numeric paging motivate U.S. manufacturers and carriers to offer alphanumeric paging equipment and services to add value. The growth of alpha paging has been hampered by two fundamental problems: Message entry is difficult, and alpha messages consume more airtime than numeric messages.

Message entry

Alphanumeric message entry requires an alpha dispatch service, a personal computer (PC) with alpha entry software or a dedicated alpha entry device.

Marion is the manager of the Pager Engineering Department at NEC America's Mobile Radio Division in Richardson, TX. Wilson is the department supervisor. NEC manufactures the model R()A4-10A/D Courier pager, which is the pager cited as an example in this article.

Alphanumeric messages (messages containing letters and numbers) cannot be entered into a paging system computer terminal without the aid of a keyboard. Several methods are used to provide the keyboard:

► *Personal computer*—The pager user's PC may contain one of the many popular programs that allow PC communication with a paging terminal. Some of these programs are terminate-and-stay-resident (TSR) programs that may be recalled by pressing a hot key that causes the alpha paging program to pop up in the middle of normal PC operations, such as spreadsheet and word processing activities. The combination makes it easy to enter alpha paging messages in an office environment with a standard PC and modem.

► *Dispatcher*—The alphanumeric dispatcher or operator listens to the message over the phone and keys in the message. Users prefer this method because it is easy for them, but the carrier must pay for labor and telephone lines.

Some dispatcher systems record the oral messages in a voice mailbox. Data entry operators listen to the recordings and key in the messages. This method reduces the number of required phone lines, but it still requires labor.

► *Dedicated entry device*—The dedicated alpha entry device is used where dispatching and PC access are unavailable. The dedicated device is a small computer and modem designed expressly for entering alpha messages.

The dedicated device works well, but access to the dedicated device is more limited, compared to a standard DTMF telephone.

Some hand-held entry devices improve access to a dedicated terminal during travel. The idea of a hand-held device has been accepted well because of the increasing popularity of palmtop computers. The difficulty of coupling modem tones acoustically to a telephone handset limits the use of the dedicated device.

Other alpha entry methods have been proposed and attempted, such as entering alpha messages with special key combinations on a standard DTMF keypad, and voice recognition. Numeric entry is the easiest to use (with the possible exception of dispatcher entry), so alphanumeric paging has experienced little growth.

Airtime

Alphanumeric paging requires almost twice the airtime as numeric paging. The difference is related to the length of the bit pattern used to represent each character.

For numeric paging, it is necessary only to represent the digits 0 through 9

Numeric paging, an American phenomenon

In the United States, 80% to 90% or more of the pagers sold are digital numeric display pagers. Pagers are becoming increasingly popular among business and personal users alike.

The percentage of numeric pager sales is not as high in many other countries. Numeric pagers are so popular in the United States because high-quality telephone service is available almost everywhere in the country. The telephone system allows users to enter numeric paging messages, usually consisting of seven-to-10-digit telephone numbers, easily via push-button telephones. Push-button telephones usually use dual-tone, multiple-frequency (DTMF or Touch-Tone) dialing.

With DTMF dialing, sending a numeric page is no more difficult than making a telephone call. In some countries, DTMF dialing is not as pervasive, making numeric message entry as difficult as alphanumeric message entry.

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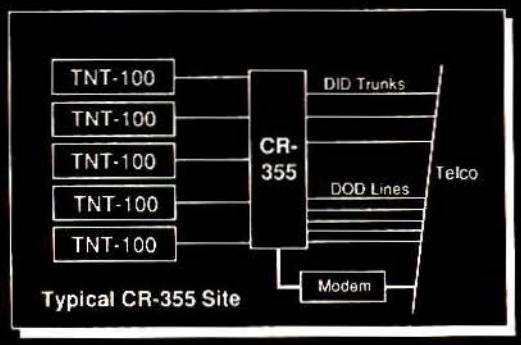
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** GENERAL USE **

30. EMERGENCY
31. URGENT
32. ROUTINE
33. CANCEL THE LAST MESSAGE
34. YOUR TRIP HAS BEEN CANCELLED
35. MEETING SCHEDULED FOR
36. MEETING RESCHEDULED FOR
37. REQUEST GRANTED
38. REQUEST DENIED
39. CANCEL DELIVERY
40. WILL MEET YOU AT
41. I WILL BE DELAYED UNTIL
42. WHAT TIME WILL YOU ARRIVE ?
43. WILL ARRIVE SOON

** MOBILE COMMUNICATION **

44. PAGE ME WITH TEL. NO.
45. SWITCH ON MOBILE PHONE
46. MOBILE PHONE HAS BEEN CALLED
47. CALL MOBILE PHONE

** CONSTRUCTION **

48. CALL JOB SITE
49. REPORT TO JOB SITE
50. STOP ALL WORK IMMEDIATELY
51. CALL SUPERINTENDENT

** REAL ESTATE **

52. CALL CLIENT
53. APPLICATION APPROVED
54. CALL TITLE OFFICE
55. CONTRACT CANCELLED

** MEDICAL **

56. REPORT TO SURGERY
57. CALL ICU
58. CALL EMERGENCY ROOM
59. CALL LAB
60. CALL NURSES STATION

** HOUSEHOLD **

61. CALL HOME
62. CALL BABYSITTER

HOTEL/RESTAURANT

63. REPORT TO RECEPTION
64. HOTEL RECEPTION
65. REPORT TO KITCHEN
66. REPORT TO HOUSEKEEPING
67. LOUNGE
68. ROOM NUMBER
69. FITNESS CENTER
70. BALLROOM

** MANUFACTURING **

71. CALL PRODUCTION CONTROL
72. CALL WAREHOUSE
73. PULL ORDER NO.
74. HOLD ORDER NO.

** OTHERS **

75. MOTORWAY CONGESTED BETWEEN JUNCTIONS
76. THE FOLLOWING HAS BEEN CANCELLED
77. EXCHANGE RATE AGAINST
78. YOUR NEXT APPOINTMENT IS AT
79. ASSISTANCE REQUIRED AT
80. YOUR TRANSPORTATION IS DELEYED UNTIL
81. THERE IS A BREAKDOWN AT
82. PLEASE CALL
83. PLEASE CALL THE OFFICE
84. PLEASE PHONE HOME
85. PLEASE PICK UP AT
86. PLEASE RETURN TO
87. PLEASE CONFIRM
88. ARE YOU AVAILABLE
89. PLEASE REPORT TO
90. PLEASE CHECK
91. URGENTLY CONTACT
92. THIS IS A TEST MESSAGE

Figure 1. Canned messages consist of a bank of preset alphanumeric messages permanently stored in the pager's electronic memory.

and a few additional symbols, such as a dash (–). These requirements can be handled easily using four bits per character, which allows 2^4 or 16 different characters.

Alphanumeric paging requires many additional characters, along with symbols to cover the upper and lower case alphabets and punctuation. The American Standard Code for Information Interchange (ASCII) seven-bit code is used, which allows 2^7 or 128 different characters.

The difference between alphanumeric and numeric airtime requirements generally may be expressed in the ratio 7/4 (seven bits ÷ four bits) or 1.75. This ratio means that, on a per-character basis, an alphanumeric character requires 1.75 times the airtime as a numeric character.

The calculation given above actually is an oversimplification. Carriers realize that alphanumeric pager users, in addition to using more airtime per character, tend to transmit more characters. A numeric page usually is seven to 10 digits, a standard phone number plus area code, whereas the typical alphanumeric message ranges from 30 to 40 characters.

Assuming a user always sends messages with an average length of 30 characters, compared to an average numeric message length of 10 characters, the alpha-to-numeric airtime ratio is: (seven bits × 30 characters) ÷ (four bits × 10 characters) = 1.75 × (30 ÷ 10) = 5.25.

Recognizing that many other factors affect system efficiency, at the very least it can be seen that alpha airtime use is a major concern. (Two other factors include POCSAG frame assignment and batching conditions.)

With so many difficulties involved with alpha paging, it is no surprise that the alphanumeric market has grown slowly. Nonetheless, this is a market that must be tapped for carriers and manufacturers to remain profitable.

Canned messages

A successful approach to alphanumeric paging must address its inherent difficulties, entry and airtime. The use of canned messages overcomes those difficulties.

Canned messages consist of a bank of preset alphanumeric messages permanently stored in the pager's electronic memory. (See Figure 1 at the left.)

The messages are retrieved from the pager's electronic memory by sending a two-digit numeric message to the pager. (See Figure 2 on page 64.)

For example Figure 1 shows that the message "Report to surgery" could be sent to a doctor by sending the numeric code 56. The message is sent exactly the same way as any other numeric message. When the pager receives the digits 56, it retrieves the message "Report to surgery" from its preset, canned message bank and displays it on the screen.

► The airtime consumed not only is less than the airtime used for an alpha message, it is considerably less than that used for a standard numeric page—two digits, compared to seven to 10 digits. In addition, the POCSAG numeric format is used, requiring only four bits per digit.

► The user enters the message the same way as a standard numeric page, so the level of message entry difficulty is not increased.

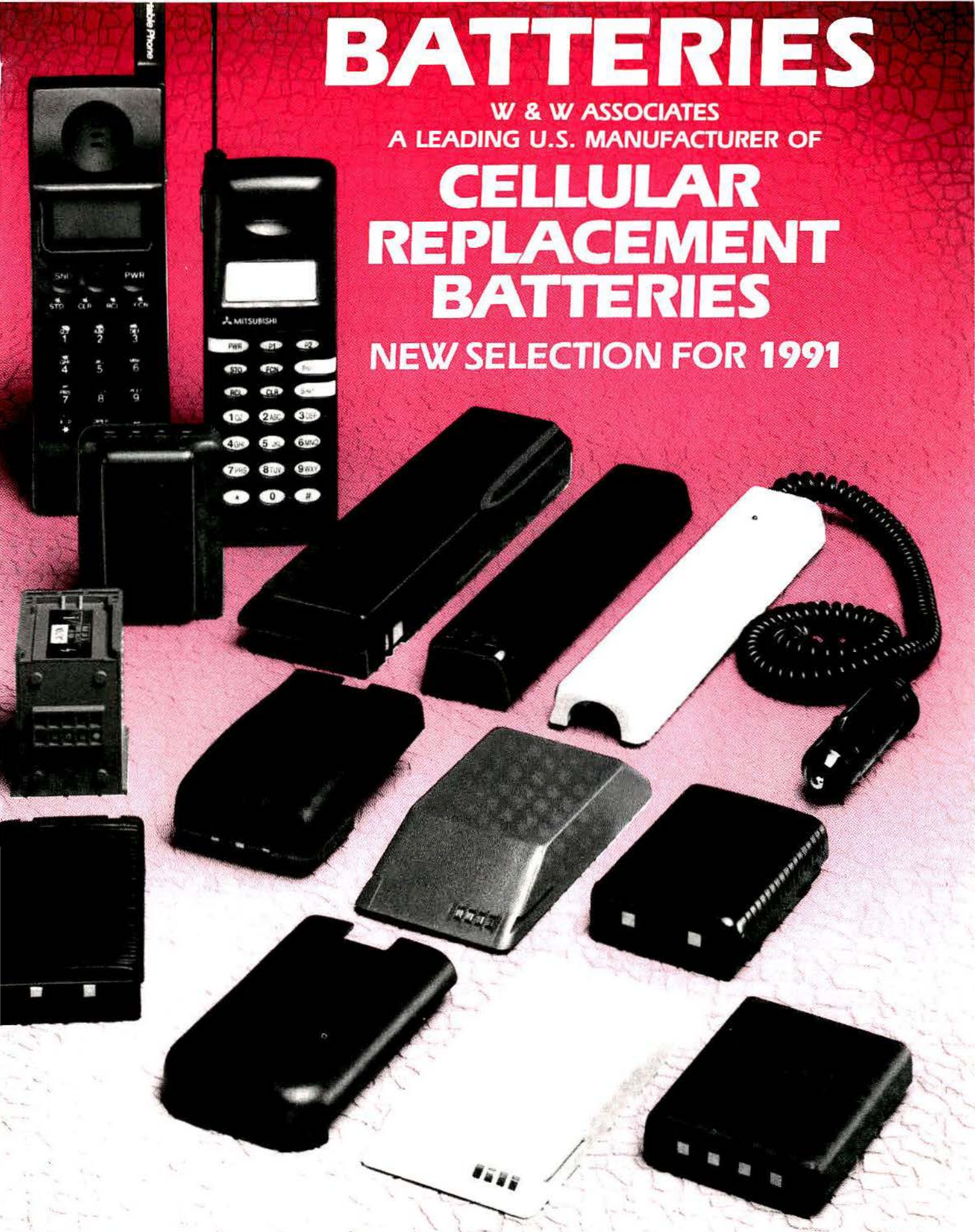
Some users might find it too difficult to use canned messages because they have to look up the number corresponding to the message they want to send, and they have to keep track of the numbers. When numeric pager use patterns are studied, though, it is seen that this requirement is not a great concern to many users.

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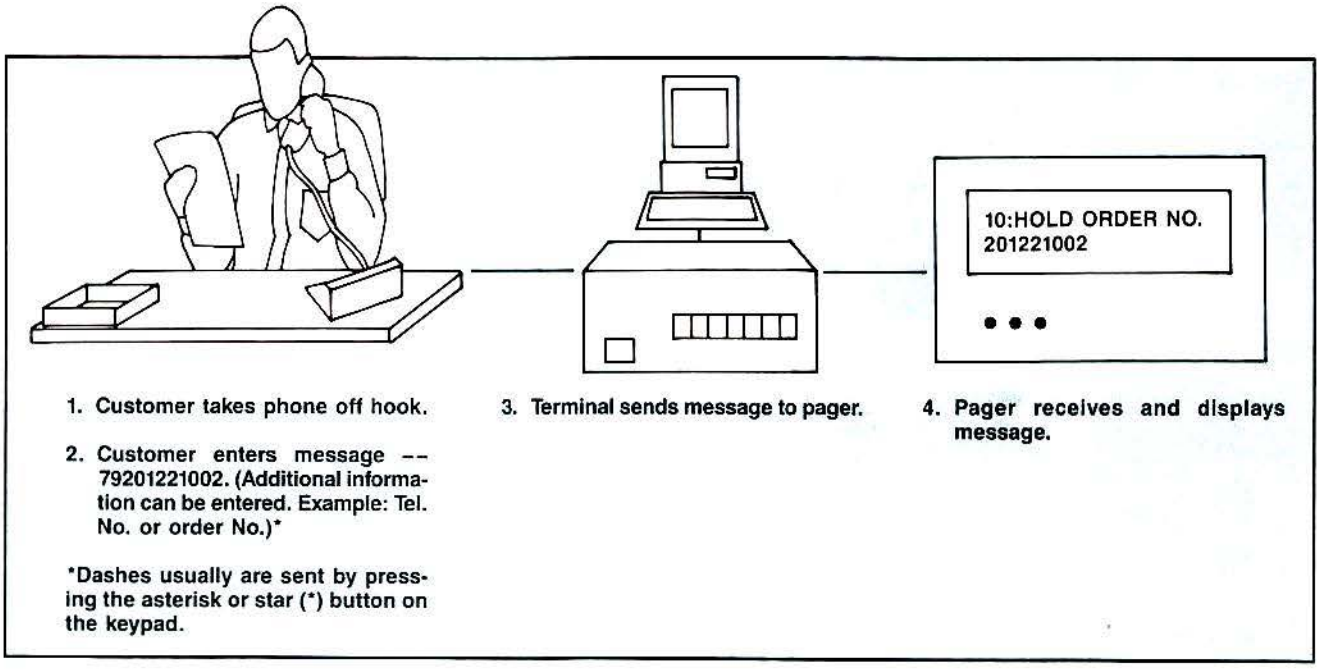


Figure 2. Canned messages are retrieved from the pager's electronic memory by sending a two-digit numeric message to the pager.

Most numeric pager users at one time or another have used numeric codes with special meanings attached when they send numeric messages to friends and family. For instance, 911 may mean "emergency" and 2 may mean "call home." Thus, numeric-coded alpha paging suits many users.

Some final concerns are system compatibility, personal canned messages and specific market usage.

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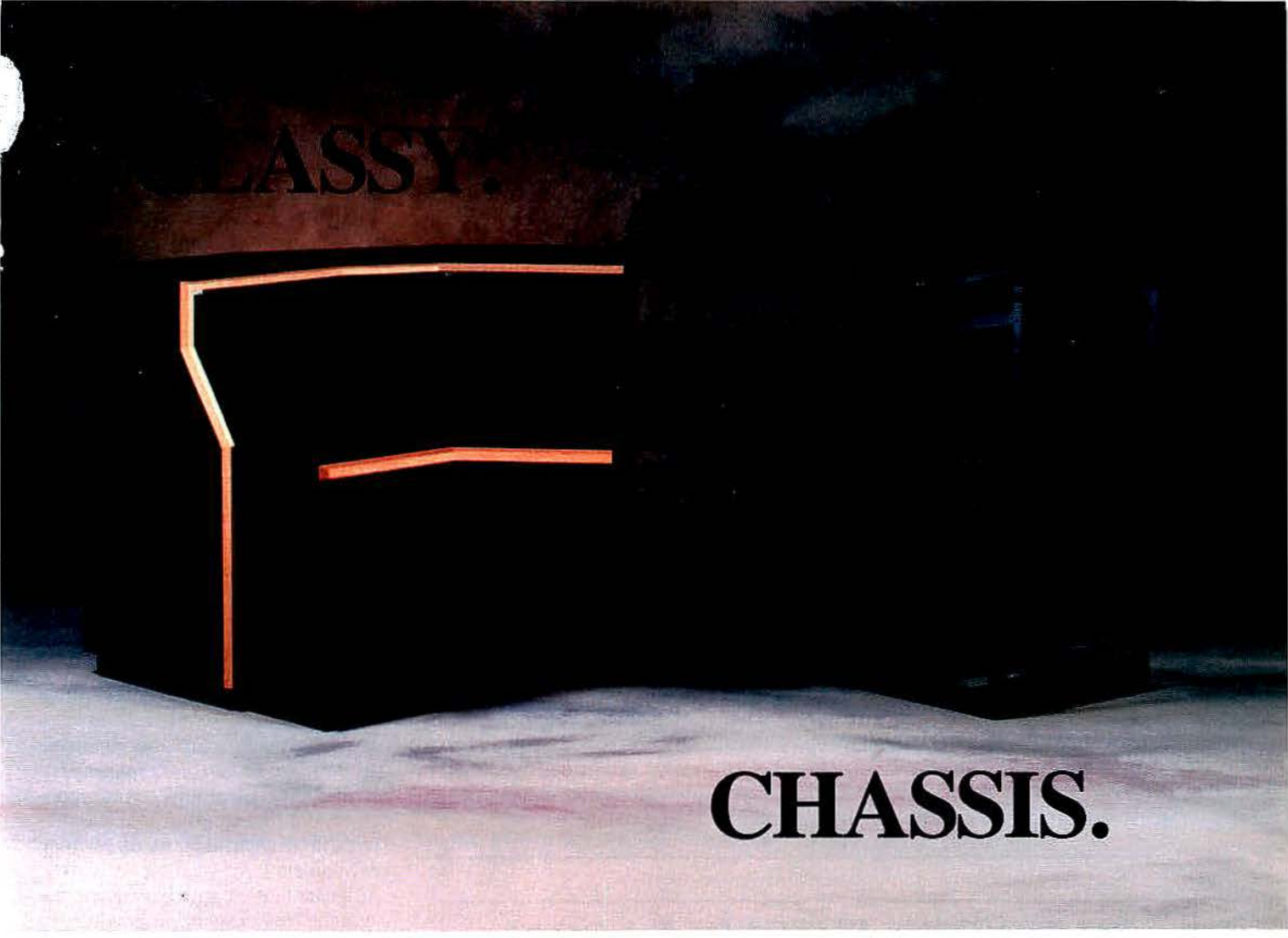
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Circle (52) on Fast Fact Card

port to surgery," is sent, system compatibility is not an issue.

When a message and a telephone number are combined, such as message 44 from Figure 1, "Page me with telephone No.," the person sending the message must enter a telephone number in addition to the canned message code. For phone number messages such as these, a method must be used to identify which part of the numeric message is the message code and which is the telephone number to be displayed.

The message code and telephone number are separated by sending two dashes before the message code, followed by the phone number. In many paging terminals, the dash (-) may be entered by pressing the asterisk or star (*) key on a standard DTMF telephone keypad.

To send the message 44 along with a phone number, the caller enters **44NNN-XXXX, where N and X represent digits in a standard seven-digit telephone number. When it receives this message, the pager displays PAGE ME WITH TEL. NO. NNN-XXXX.

Some paging terminals may be capable of the ** signaling format for including phone numbers at the ends of messages. Others may lack this capability. Therefore, messages that require phone numbers and messages that do not have been included in the message bank, allowing the canned message feature to be compatible with many existing paging systems.

In addition to the bank of 63 preset canned messages, the pager may be programmed with 10 additional messages. Although the message bank is comprehensive in its message coverage, all possible alpha messages never can be covered. The programmable messages allow the user to tailor messages for specific situations.

Alphanumeric pagers are used in many different industries for improving mobile communications efficiency. Unlike the numeric pager, a full and complete message can be delivered that, in many cases, does not require a return call.

The message bank is divided into several short lists of messages that directly pertain to common alphanumeric paging users. Groups include medical, construction, real estate, general office and others. These lists serve industries or market segments of alpha users.

...carriers have the opportunity to enhance their services without making life difficult for users...

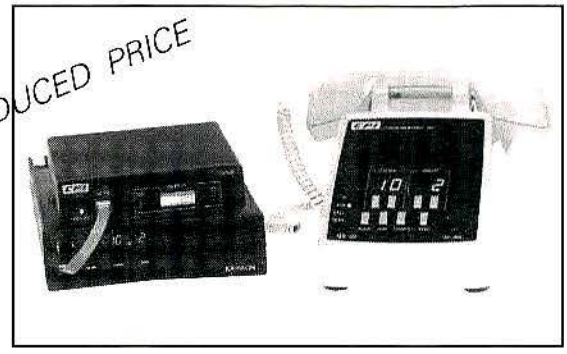
Although the canned message bank was designed primarily to enhance numeric paging capability, it has applications for reducing airtime requirements in an alphanumeric dispatching environment.

Alphanumeric usage is available because the pager may be programmed to respond to coded messages, such as --44, that are transmitted using the POCSAG seven-bit alphanumeric format. This method allows a user or dispatcher to add an alphanumeric message to the end of the canned message. For example, the message PAGE ME WITH TEL. NO. WHEN YOU GET A CHANCE could be transmitted to the pager using the following sequence: --44WHEN YOU GET A CHANCE.

In this case a canned message was received, but only approximately half of the message was transmitted. Using this alphanumeric format provides a method for airtime reduction, but the alpha entry difficulty remains.

Canned message paging can reduce airtime requirements significantly and simplify the process greatly for the typical numeric pager to send alphanumeric messages. Through this new alphanumeric paging method, carriers have the opportunity to enhance their service offerings without making life difficult for users and without seriously affecting their airtime resources.

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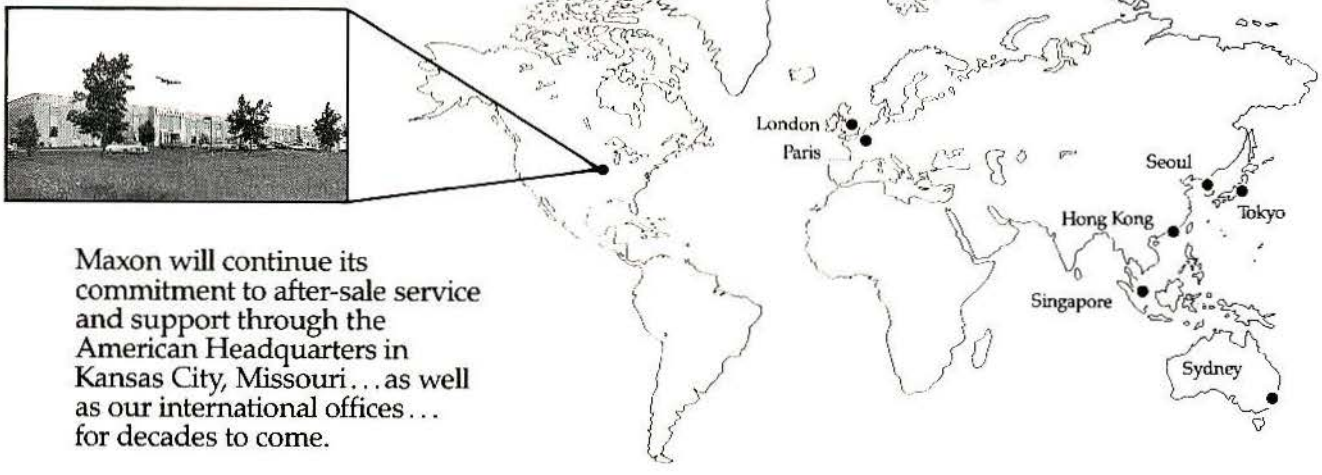


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Circle (54) on Fast Fact Card

Gross receives Avante Garde award from IEEE Vehicular Technology Society

The Institute of Electrical and Electronics Engineers' Vehicular Technology Society (VTS) gave its Avante Garde award to Al Gross on May 21. The award is bestowed for pioneering leadership and continuing contributions in promoting new technology in the field of vehicular communications and electronics.

Gross, known as the "father of Citizens and Personal radio," developed a compact hand-held transceiver that was the first 460MHz equipment to receive FCC type approval in March 1948. At the IRE convention in New York City, the FCC chairman announced the type approval. To achieve the required frequency stability, Gross used silver circuit traces on a ceramic substrate, a forerunner of modern integrated circuit chip composition. The approved units were an outgrowth of the hand-held UHF transceivers he developed and that were used for clandestine service during World War II.



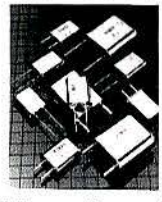
Al Gross speaks to an audience at the IEEE Vehicular Technology Conference.

At the VTS conference, Gross displayed hand-held transceivers he developed in the late '30s, '40s and '50s, as well as the first selective radiopaging system.

Among the equipment on display were the prototype 300MHz hand-held transceivers he built in 1938. Magazine publicity of his experiments in Ohio became known to the War Department's Office of Strategic Services. Gross was called upon to build an air-to-ground communications system using his transceivers. His association with FCC commissioners and the commission's chief engineer during the war years led to the creation of the 460MHz-to-470MHz Citizens Radio communications service allocation in 1946. Eight channels of the original 10MHz-wide UHF Citizens Band allocation remain as the renamed General Mobile Radio Service.

Gross' continuing work has included research and development for missles and satellite applications, including electromagnetic compatibility, interference and susceptibility control for the military and industry. He is an electrical engineer with the Space Data Division of Orbital Sciences, Chandler, AZ.

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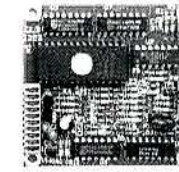
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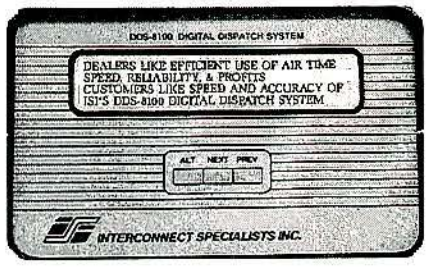
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Circle (57) on Fast Fact Card

Motorola, Fleet Call plan digital rollout in 1993

Digital radio communications equipment manufactured by Motorola, Schaumburg, IL, will form the backbone of radio communications networks to be constructed beginning in 1993. Fleet Call, a specialized mobile radio (SMR) system operator based in Rutherford, NJ, will be among the first to use the new equipment. Motorola is the largest owner and operator of SMR systems, and Fleet Call is the second-largest.

Current SMR systems use analog frequency modulation (FM) technology, almost always with high-powered base transmitters connected to antennas at high elevations. Dubbed "Motorola Integrated Radio System" (MIRS), Motorola's new technology uses multiplexed digital linear modulation.

Time-division multiplexing, as implemented in the new system, allows six individual communications to take place over the same radio channel.

The system is digital because it converts analog signals to binary codes. For example, voices are converted to a series of digits—ones and zeroes—prior to transmitting them via radio. The conversion allows information to be transmitted faster, a requirement for successful time-division multiplexing.

Linear modulation, also referred to as amplitude modulation (AM), helps to confine the transmitted signals to the bandwidth specified by the FCC rules for SMR operations.

Channel reuse

Fleet Call plans to convert its systems to use low-powered base station transmitters connected to antennas at low elevations. This configuration allows the same radio channel to be used in different parts of a metropolitan area or region. The combination of MIRS and low transmitter power and antennas is expected to boost capacity on the company's systems by a factor of 15.

Under terms of a conditional agreement between the companies, Motorola will sell Fleet Call system equipment and finance at least a portion of the purchases. Altogether, Fleet Call is expected to spend between $700 million and $1 billion to install the new systems in its six target markets: Los Angeles, San Francisco, New York, Chicago, Dallas and Houston.

Construction plans

Motorola will construct digital systems on its own SMR channels in at least 50 top markets by 1993. The company intends to offer the technology to other SMR operators on a nationwide basis, too.

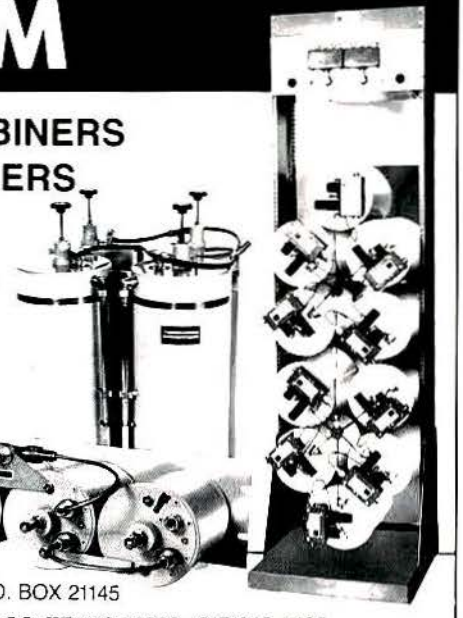
Implementation can be gradual in situations where a complete changeover is impractical. One channel of a trunked SMR can be converted, multiplying that channel's capacity by six times. Meanwhile, the remaining channels operate with analog FM as before.

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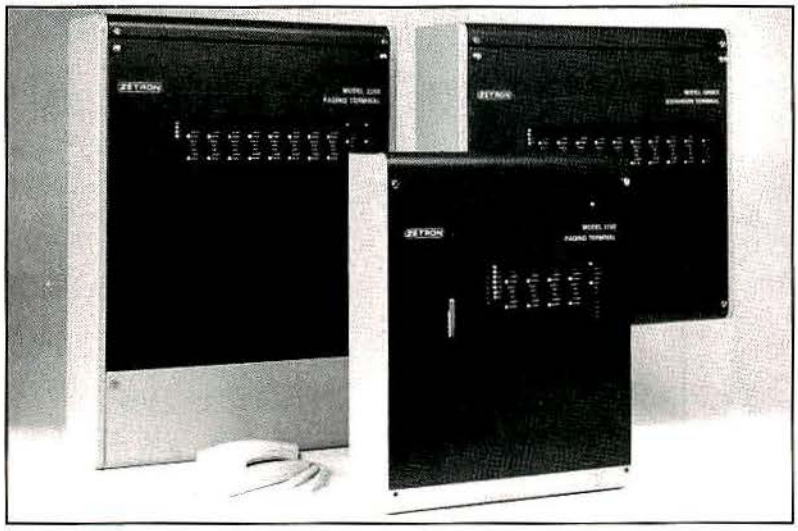
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Land mobile interference complaints are increasing

Chicago's FCC Field Operations Bureau office answers 500 to 600 telephone calls per week, according to engineer-in-charge Philip Bradford. "Much of our time is spent resolving interference complaints about TV reception and telephone communications," he explained. "Complaints involving land mobile radio communications are a close second because of the proliferation of transmitters on the shared frequencies."

Land mobile interference complaints are rising, and Bradford said conditional licensing may be contributing to the increase. Conditional licensing allows license applicants to begin operations when frequency coordination is complete and before the license document is issued. Hearing the new, conditionally licensed station for the first time, others on the channel may mistake the new station for an unlicensed operation and complain about it.

A second cause is a general misunderstanding among radio users on shared frequencies: Many believe channel assignments are exclusive or private. "Sometimes the complaint is: 'We hear someone on our frequency,'" he said. "We tell them the frequency is not private. A radio equipment salesman may have told them about 'Private Line.' Sometimes people take it literally to mean no one else is supposed to be on the frequency."

Private Line is a Motorola trademark for continuous-tone controlled squelch system (CTCSS) circuitry. Many manufacturers offer such a feature. CTCSS helps to quiet the radio when others use the channel, but it does not prevent interference. Moreover, many mobile radios bypass the circuit when the microphone is lifted. This function helps the user to monitor before transmitting and to avoid causing interference. When someone is using the channel, others must wait. Some new users are surprised to hear other voices on the radio when they lift the microphone to make a call.



Philip Bradford: 'Complaints involving land mobile radio communications are a close second [to TV and telephone interference complaints] because of the proliferation of transmitters on the shared frequencies.'

"Once we explain how these channels are allocated and set up, then we start working with whatever the problem is," Bradford said.

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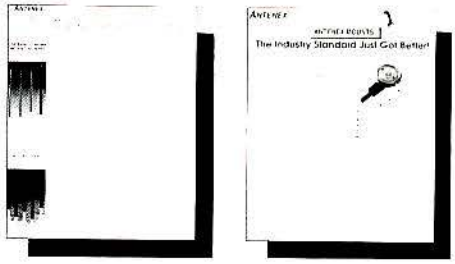
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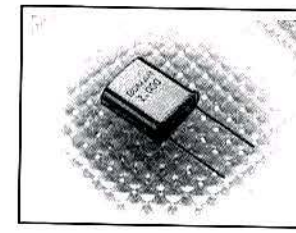
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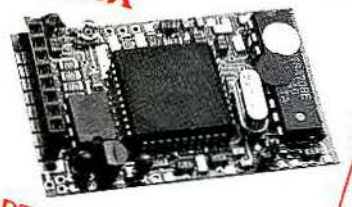
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Interference complaints

These are the most common reasons for co-channel mobile radio interference complaints at the FCC Chicago office:

- ☐ **Users misunderstand the meaning of Private Line tone-controlled squelch: They mistakenly believe they have an exclusive channel and complain about other stations they hear.**
- ☐ **Users misunderstand the nature of shared channels: They are suspicious of new licensees assigned to the same channel and report them as unlicensed operators.**
- ☐ **Users do not monitor before transmitting, and others report the interference that results.**
- ☐ **Users lose patience and transmit before another operator is finished with a call. Sometimes this behavior causes animosity and a spiral of retaliatory interference that is difficult to resolve.**

"For example, when a new licensee starts using a shared channel, especially in a crowded environment such as Chicago, other users may call us to say there is an unlicensed station on the channel. We ask for enough information to identify the new licensee so we can investigate with the database. The best information is a call sign, but we use telephone numbers, names and locations, too."

Next, the FCC office staff telephones the National Association of Business and Educational Radio (NABER). "We ask, 'Have you coordinated for this company?' NABER is very much a part of the process because 90% of the applications requiring coordination go through NABER before reaching the commission."

Usually, Bradford said, NABER confirms the new user applied for a license and gives his office the new user's name, address and phone number. "We call the complainant and confirm that the new user is licensed. Then we call the new licensee and explain how to operate the radios. The new licensee may not know that operators must listen before they transmit."

Base stations may not be designed the same way, so the dispatcher has to press the MONITOR button before keying the microphone. "Sometimes that procedure is better known in theory than in practice," Bradford said.

Impatience plays a role. "If a mobile operator who wants to make a call monitors and hears someone pause briefly during an exchange of transmissions, he may say to himself, 'I've been standing by long enough, I've got to talk.' When you listen to a crowded channel, you can almost hear the impatience. That guy is ready to go. He thinks the other guy has been on there too long—even though it may have been only 30 seconds."

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FCC fines radio service for aiding, abetting

In an action stemming from a complaint from a two-way radio licensee, the FCC Field Operations Bureau (FOB) has fined a radio service company $1,000.

Questar Radio, Denver, paid the fine without comment after receiving a Notice of Apparent Liability from Robert D. Weller, the engineer-in-charge at the FOB's Denver office. Questar was charged with "inciting, aiding and abetting the wilful and repeated violation of Section 301 of the Communications Act," the notice reads. Section 301 expresses the government's requirement that radio transmitters be licensed.

According to the FCC, Questar installed radio equipment on behalf of its customer, C.R. Anderson Construction, Denver, for use on a community repeat-

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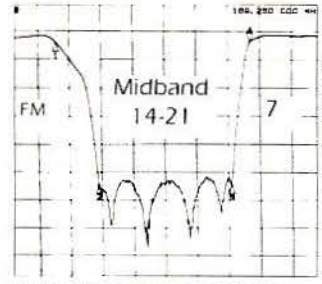
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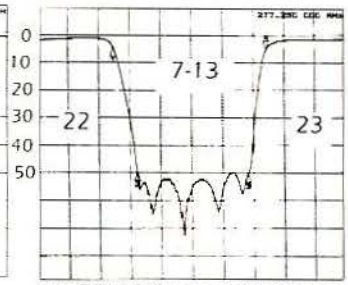
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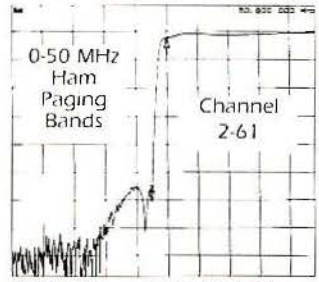
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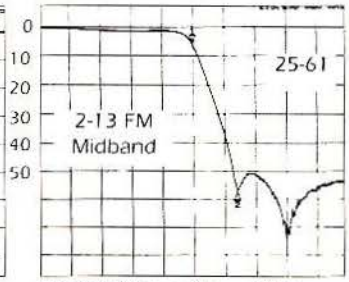
5KMT-A/H Channel 14-21 Trap



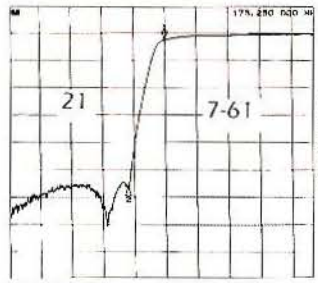
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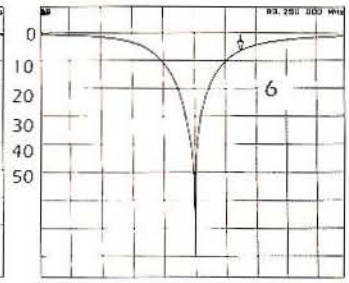
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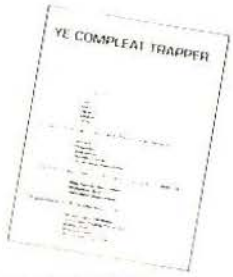


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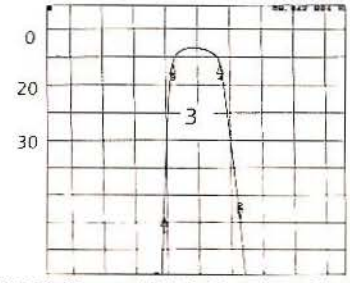
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er, and advised Anderson that the equipment could be used without waiting for a license. Anderson's unlicensed operations were noticed by a licensee on the same repeater. FCC investigators traced the location of the unlicensed operation's control station to Anderson.

Questar installed Anderson's radio equipment on March 4, 1991. Questar received Anderson's license application on April 15; NABER coordinated the frequency on April 19; and the FCC received the application on April 23. Under terms of the conditional licensing procedure, authority to operate the radio system was not effective until April 23, the FCC notice reads.

"We're seeing more problems out of Denver with radio companies putting users on the air unlicensed," said Joe Di Scipio, a public affairs specialist in the FCC Denver office. "Rather than punish the user who doesn't know better, we're looking to punish the radio company that should know better."

The manager of Questar's Denver office, John Hoggatt, said: "It was our fault, but it was an honest mistake and not something we did on purpose. We loaded a customer on a frequency and tone before the license application reached the FCC. There were all kinds of reasons for slowdown—some on our part, some on the FCC's part. The FCC had been flooded by applications for 220MHz channels."

Hoggatt described the fine as "a slap on the hand, but it could have been a lot worse. I'd just as soon it would have been 'zero fine.' But a fine's a fine, and we corrected the problem within 24 hours of receiving the FCC notice."

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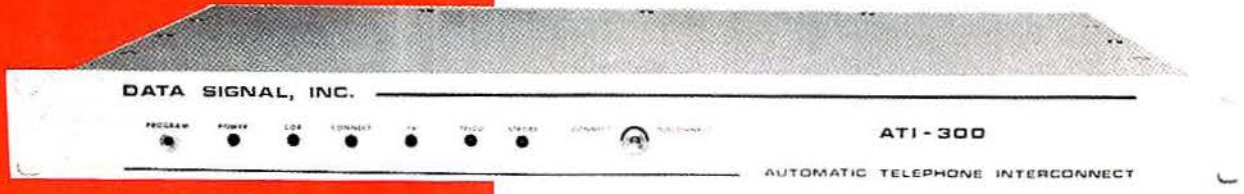


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Readers' choice

Of all the new products and services in the April issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them: Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

Mobile antenna incorporates four-band performance

The Spectra mobile antenna covers four bands in a single antenna. Bands include lowband VHF, highband VHF, UHF and 800MHz to 1,000MHz. The **Austin Antenna** product handles 100W power.

Circle (516) on Fast Fact Card

Remote for duplex radio enables phone, fax use

The Connec-Tel remote from **Northern Controls & Communications** provides a standard RJ-11 input and output to a full duplex radio. The connection enables use of standard telephone equipment, fax machines, modems and cordless telephones on interconnected radio systems. The remote features DTMF, CTCSS or external decode; CTCSS encode; and automatic ANI.



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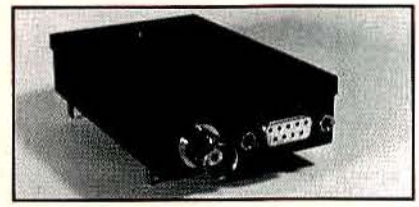
Remote monitoring system sends alert message to pager

The Pagnow remote monitoring system automatically alerts a pager with a message of a problem and its location. Available from **Compuquest,** the unit monitors buildings and entrances; smoke, fire or water alarms; equipment; restricted areas; and communications facilities. The monitoring system has an internal rechargeable battery that provides backup for as many as six hours.



Circle (514) on Fast Fact Card

Data, telemetry radio offers fast attack time



Model KS-900 UHF transceiver from **Tekk** features a fast attack time, 2W RF power and a 0.35μV receiver. The data and telemetry radio operates as high as 9,600 baud and is about the size of a credit card.

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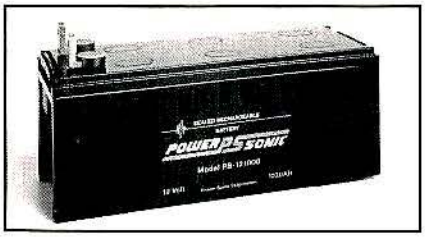
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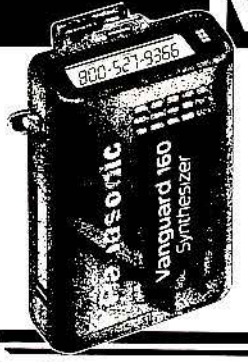
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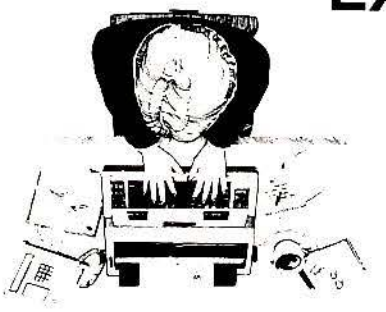
NUMERIC

Panasonic

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 - VHF (980 frequencies) – Cap Codes
 - UHF (400 frequencies) – Pager Functions
 - 900mhz
- POCSAG Signaling Format
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Express yourself

Something bothering you? Want to sound off about it?

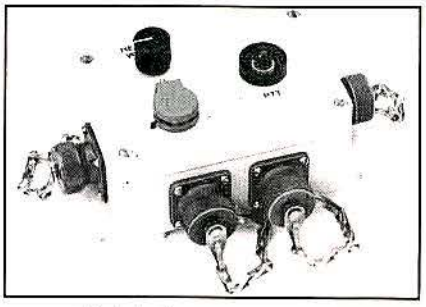
Need help that other readers might provide?

Send a letter to:

Letters to the editor
Mobile Radio Technology
P.O. Box 12901
Overland Park, KS 66212

Headset module allows access to two-way radio

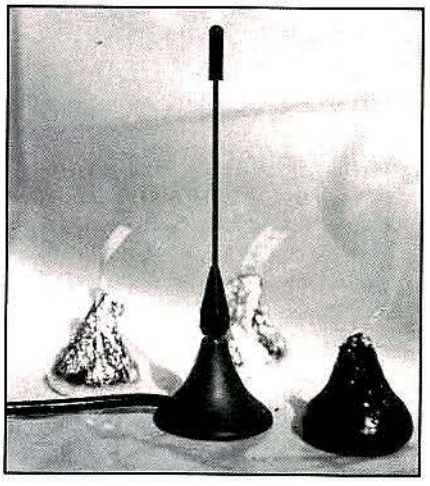
The U3815 headset station and radio interface module works with **David Clark's** series 3800 communications system. The module connects to the system's intercom and allows access to a two-way radio.



Circle (221) on Fast Fact Card

Isolated antenna bases hold various whips

The Iso-Range bases and antenna whips from **Les Wallen U.S.A.** are available for various mobile radio communications bands, including commercial, marine and cellular. The bases come in three versions: Isofast, which



is a self-adhesive surface-mounted base requiring no holes; Isopan, which is a self-adhesive surface-mounted antenna base with the feeder routes directly downward; and the Isomag, a magnetic-mount unit. The isolated bases are approximately the size of a bite-size chocolate kiss and offer low-loss mounting and broad bandwidth.

Circle (234) on Fast Fact Card

Resistors, capacitors satisfy surface-mount uses

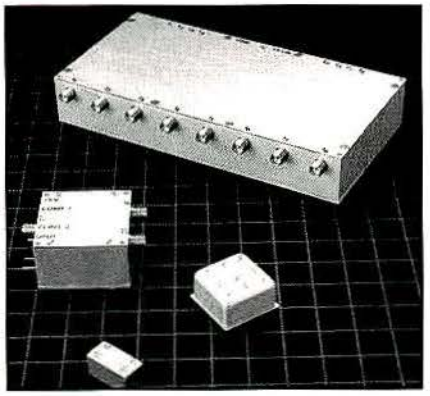


Resistors and capacitors for surface-mount applications are available from **Communications Specialists** in small quantities and in individual values. The components suit demand for refills of individual units from the CC-1 and CR-1 surface-mount capacitor and resistor prototyping kits. Resistors come in strips of 10, and capacitors come in strips of five. Components are sold per strip, and each strip has the values marked.

Circle (388) on Fast Fact Card

RF switches boast fast switching speeds

RF switches from **JFW Industries** come in many packages and styles and features solid-state high power, frequency ranges as high as 3GHz and fast switching speeds. The units come in plug-in and stripline packages.



Circle (220) on Fast Fact Card

Microwave path analysis includes various calculations

Computer software for microwave, multipoint, topographical and terrain data applications is available from **Technical Communications Software.** The microwave path analysis software covers inverse position azimuth and distance calculations; microwave path propagation; path reliability calculations; path reflection; and noise power ration. The Topo-Graph topographical software includes vertical scale selection; earth curvature selection; and antenna height adjustment.

Circle (208) on Fast Fact Card

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Circle (72) on Fast Fact Card

INTERFERENCE LOCATION



★ 50 to 1000 MHZ
★ Stuck Microphones
★ Cable TV Leaks
★ Jammed Repeaters & Cell Sites



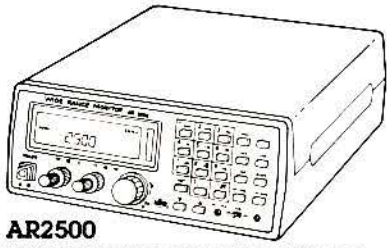
New Technology (patented) converts any VHF or UHF FM receiver into a sensitive Doppler shift radio direction finder. Simply plug into receiver's antenna and external speaker jacks. Models available with computer interface, synthesized speech, fixed site or mobile - 50 MHz to 1 GHz. Call or write for details.

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Circle (73) on Fast Fact Card

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Circle (74) on Fast Fact Card

New products

Vehicle logging system downloads data to PC



The Exec-u-log fleet management system from **Execulog** monitors vehicles and drivers automatically, and the information can be downloaded to a PC for analysis and reports.

Circle (251) on Fast Fact Card

Tweezer handpiece tool removes SMDs safely

The ThermoTweez handpiece from **Pace** grips surface-mount components and leads, directing controlled conductive heat directly to the joints to avoid damage to adjacent components. The tweezer unit has a vertical design.

Circle (450) on Fast Fact Card

DTMF decoder boasts low power consumption

Model TTD-4S DTMF decoder can be programmed locally or over-the-air with DTMF commands. The decoder from **Northern Controls & Communications** offers selective, group and all call and provides for access lock. The decoder includes two relays with latched and momentary outputs, a latched or flashing transistor output and a separate momentary latched transistor output. Any relay or transistor can be reset with the auto reset feature.

Circle (326) on Fast Fact Card

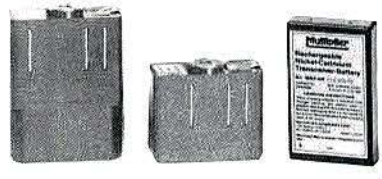
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Circle (75) on Fast Fact Card

Alignment oscillator tests 350kHz to 55MHz



The FOT12-A alignment oscillator includes six crystal positions for testing or alignment in the 350kHz-to-55MHz range. The oscillator boasts adjustable output selection from the front panel. The **ICM** unit has an internal battery and power jacks on the rear panel for external dc power input.

Circle (243) on Fast Fact Card

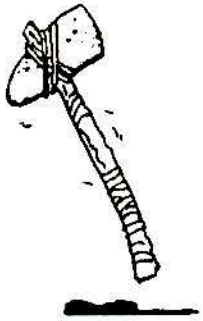
Packet radio system suits land, maritime fleets

The Mavric 2000 land and maritime packet radio system from **Metric Systems** permits users to send and receive text and image data using VHF, UHF and 800MHz channels. Features include point-to-multipoint operation, secure communications and protection from on- and off-channel interference. The system works with any IBM-compatible PC.

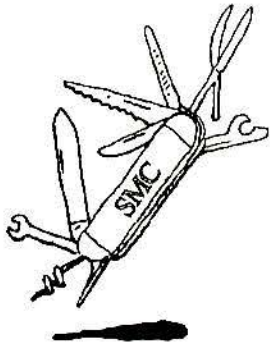
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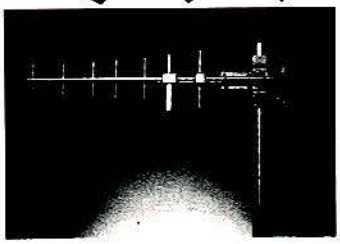
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db PRODUCTS
DECIBEL



DB498 and DB499 heavy duty Yagis for 806-960 MHz

Made of high-strength welded aluminum alloys protected by a gold anodized finish, these Decibel Yagis feature an enclosed feed of unique design and a covered radome for moisture and ice protection. They resist winds to 150 mph.

Specifications
Range: 806-960 MHz
Bandwidth: 62-72 MHz
Gain: DB498 – 9 dB
DB499 – 10 dB
Power: DB498 – 100 watts
DB499 – 150 watts
Front-to-Back Ratio:
DB498 – 18 dB
DB499 – 20 dB
Polarization:
DB498 – vertical
DB499 – horizontal or vertical

An additional 3 dB gain can be achieved by using dual antennas with appropriate harness.

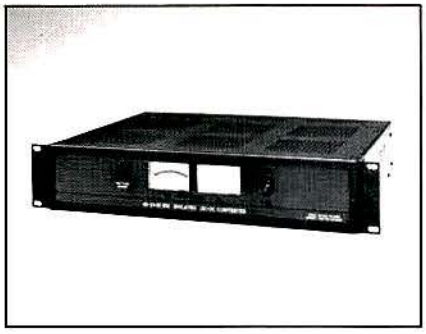
A unique mounting arrangement permits rapid azimuth orientation and, with the DB499, either vertical or horizontal polarization.

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HUTTON

Circle (77) on Fast Fact Card

48V input dc converters feature low ripple



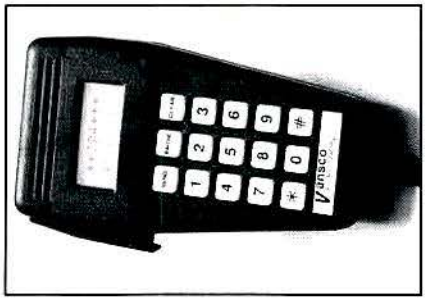
Rack-mount dc converters from **Newmar** accept 48V positive, negative or floating ground input and feature low ripple. The input converters offer 400W continuous output and isolate conversion from 48V to 24V or 48V to 12V. Mounting brackets are provided for a 19-inch or 23-inch rack-mount. Fail-safe components guard against over-voltage condition.

Circle (512) on Fast Fact Card

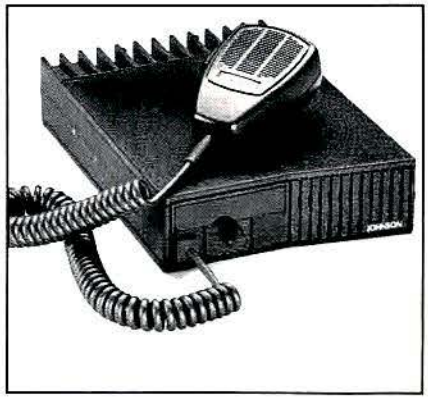
Tone dialer, mic combo has 16-digit LCD

The Micro-Dialer hand-held DTMF tone dialer and mic combination from **Vansco Electronics** includes a 16-digit LCD, keypad and PTT. The case is made of black ABS. Power and signal conductors are housed in a black neoprene retractile cable. The unit can be powered from a 12V supply.

Circle (261) on Fast Fact Card



Trunking mobile features 15W output, 10 systems



The newest 800MHz AmeriCom Networking trunked mobile from **E. F. Johnson** provides roaming with automatic check-in: over-the-air programming and updates; unique ID codes; and 10 stored numbers. The mobile features 15W output and 10 systems with one group per system.

Circle (265) on Fast Fact Card



The Most Important New Test Equipment You'll Buy Comes From DCT

DCT's new SNA scalar network analyzers are everything you asked for in test equipment.

- Portable. The first field worthy, hand-held units.
- Versatile. Analyze antenna, connector, T-line, filter, amplifier and receiver performance.
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- SNA 900 for 700 to 1300 MHz.

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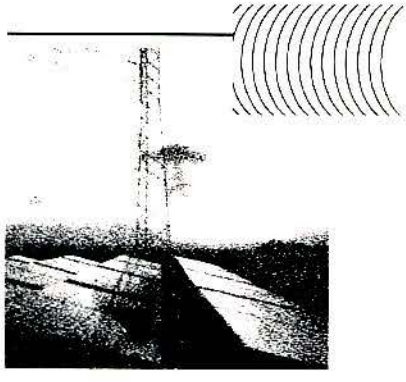
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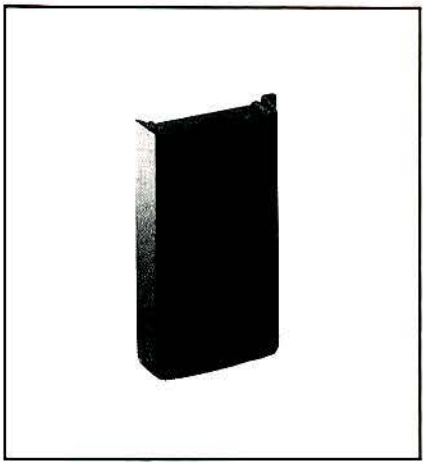
Solar Electric Specialties
P.O. Box 537, Willits CA 95490
800 344-2003

SES

Siemens Solar Industries

Circle (79) on Fast Fact Card

Battery pack incorporates short-circuit protection



The PX-87A replacement battery pack that fits Standard 834S, 743L, 834L and HX300 radios includes improvements. The **Periphex** battery houses an internal overcharge circuit and offers short-circuit protection.

Circle (228) on Fast Fact Card

Wireless intercom headphones offer 1- to 2-mile range

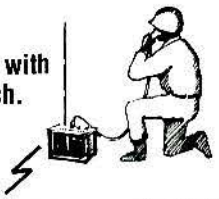


FM wireless intercom headphones span distances of 1 mile to 2 miles and feature a built-in FM transmitter, receiver, flexible antenna and rechargeable NiCd battery. The **R-Columbia Products** noise-attenuating headsets are lightweight and crystal-controlled. Model TR-160 operates in VHF, and model TR-470 is UHF. Output power is 1W, and the headsets are available in various configurations such as single ear or hard hat models.

Circle (385) on Fast Fact Card

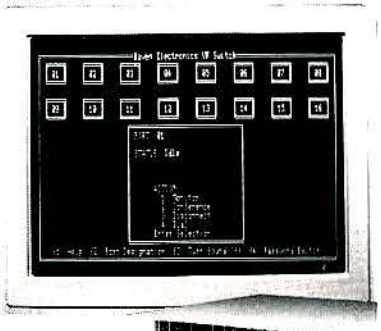
Interoperability!

Radio and network interoperability are now at your fingertips with Raven's new Model 376 PC-controlled Voice Frequency Switch.

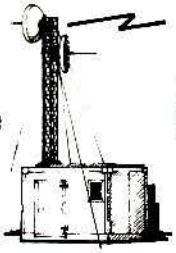




Easy-to-read color display shows current status on a port-by-port basis. Port designation, security passwords, monitoring, conferencing, and supervisory override features are all standard and field-selectable or programmable. Switch control is via keyboard or DTMF signaling.

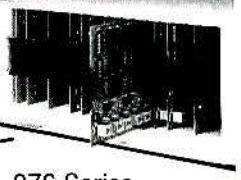


Applications include mobile radio base station crossbanding, public/private telephone network access, satellite engineering service channel (ESC), microwave network service channel routing, and more.



Whether your needs are concerned with general audio network control, field communications, or interagency coordination, the Model 376 is the answer.





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Price Includes:
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SYNTHESIZED

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8 CHANNEL **$189.00***



Our State-of-the-Art synthesized design makes extensive use of surface mount technology to reduce the size of components and eliminate excessive heat build-up. This combination produces a radio with extremely high frequency capability and minimal deviation characteristics.

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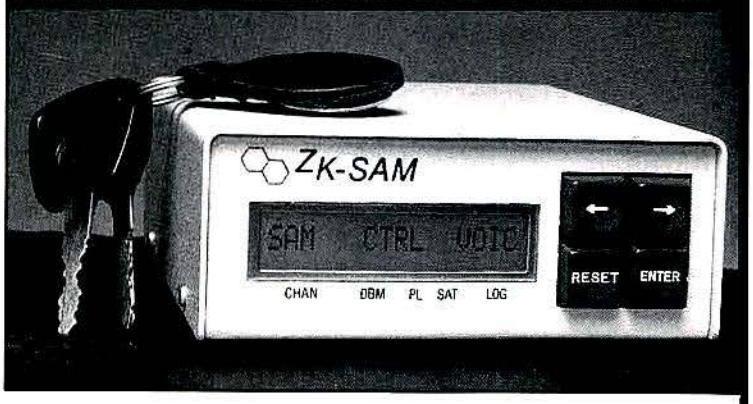
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ZK CELLTEST INC.

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New products

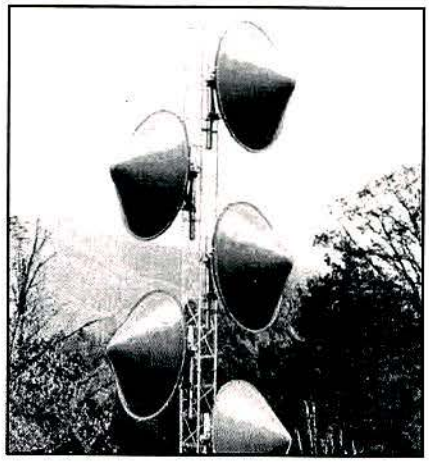
Dispatch system incorporates automatic vehicle positioning



ASCAR Dispatcher from **ASCAR Business Systems** includes the integration of digital devices, vehicle positioning and dispatching technology. The order taking and dispatching system provides digital communication to the driver and automatic vehicle positioning to the dispatcher via a large screen graphic display. The hardware, software, consulting and system support are provided by the company.

Circle (403) on Fast Fact Card

Parabolic antennas meet new FCC band allocations



Parabolic antennas designed for fixed service use in the FCC's newly allocated 932MHz-to-935MHz and 941MHz-to-944MHz spectrum are available from **Mark Antennas.** The antennas come in grid, solid, high and maximum high-performance models.

Circle (447) on Fast Fact Card

Literature

Catalog lists power supplies

Battery chargers, power boards and power supplies are detailed in **Good-All Electric's** catalog. General descriptions, standard specifications and output ratings are included in the 40-page catalog.

Circle (353) on Fast Fact Card

Data describes cellular accessories

Cable assemblies; replacement antennas; cellular antennas; cellular accessories; antennas and kits; and connectors are listed in **JB Communications'** catalog. Descriptions and sketches are included.

Circle (466) on Fast Fact Card

Workbook generates marketing suggestions

"The Do-able Marketing Plan" by Adrienne Zoble is a 75-page looseleaf workbook of marketing suggestions published by **Adrienne Zoble Advertising.** It includes examples of how to benefit from memberships in business associations and how to generate referrals from customers.

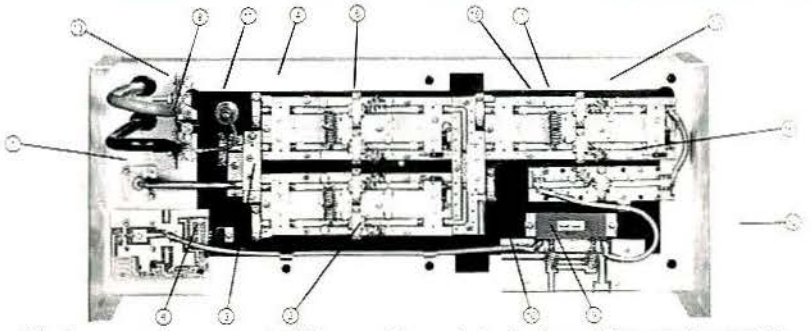
Circle (356) on Fast Fact Card

Catalog lists electronic components

Purchasing manual 566 provides product data and pricing on more than 35,000 electronic components and more than 80 manufacturers. The catalog from **Mouser Electronics** includes a new products section and product index tabs for fast product location.

Circle (406) on Fast Fact Card

16 REASONS TO BUY OUR RF AMPLIFIERS



A bad amp can be your worst nightmare. Ask us what we've been doing over the past 11 years to make your dreams come true. Our Catalog details 16 important technical points you should know before you make a commitment to an RF amplifier supplier. Our product line includes:

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- True continuous rating at high ambient temperatures
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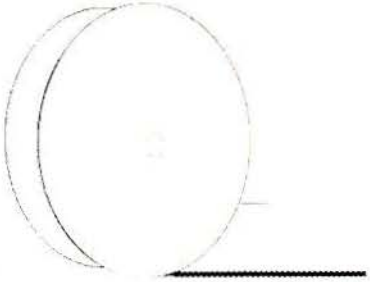
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HUTTON

Circle (84) on Fast Fact Card

Readers comment on war, communications

The Gulf War has come and gone, and its long-term and short-term effects on the mobile communications industry are still being examined. During the height of the action, respondents to the April "What Do You Think?" questionnaire commented on the war's effect on their land mobile radio businesses.

Of the respondents, 17.1% reported reductions in staff due to reservists call-ups to the military effort. A mere 2.4% of the respondents reported increased sales during the action, and 31.7% said sales were down.

According to 29.3% of the respondents, the Gulf War had no effect on their operations, and 7.3% said it was too early to tell the impact.

Long-term impact

In the long term, respondents listed the following impacts of the Gulf War:

- "Ongoing new supply contracts for portable communications."
- "Future budget cuts in other departments to increase spending in DOD."
- "Things will be close to normal in one year."
- "At this time, we are not experiencing any changes in our company."
- "Positive. We have many military suppliers locally."
- "Good in long term, rough right now though."
- "Very slow pay from customers due to the recession."

Some mobile radio respondents adapted their communications products to suit military applications in conjunction with the Gulf War including "modified some portables and mobiles for high reliability and flexibility in places where there are no service facilities;" "special high-capacity trunks installed on nearby military reserve bases;" and "classified modifications."

Most companies were not involved in consulting, engineering and site development for the war effort, however, some companies provided such services.

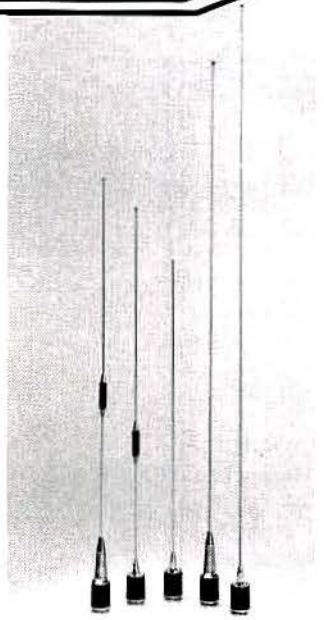
Be sure to fill out this month's "What Do You Think?" questionnaire on page 105 so your responses can be included in a future "Feedback" column.

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Circle (85) on Fast Fact Card

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NEWMAR'S MAINTENANCE CHARGERS AUTOMATICALLY MONITOR MULTIPLE BATTERY BANKS KEEP THEM IN PEAK CONDITION. THE SYSTEM CAN BE LEFT UNATTENDED FOR EXTENDED PERIODS WITHOUT BATTERY DAMAGE, SAVING ON BOTH COSTLY SERVICE CALLS AND BATTERY REPLACEMENT .

THE RUGGED ANODIZED ALUMINUM CASE WILL SURVIVE THE RIGORS OF PERMANENT VEHICLE MOUNTING OR BEING BOLTED TO THE WALL OF A REMOTE COMMUNICATION SITE.

USE NEWMAR CHARGERS AND THE CONDITION OF YOUR BATTERIES WILL BE ONE LESS THING FOR YOU TO WORRY ABOUT.

NEWMAR

RELIABILITY BEYOND COMPARE

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Circle (86) on Fast Fact Card

People


Herlin


Katz


Watkins

Devra Herlin, an account executive with E. F. Johnson in Syracuse, NY, leaves that post to join Midland LMR, Kansas City, MO, as area sales manager for New England.

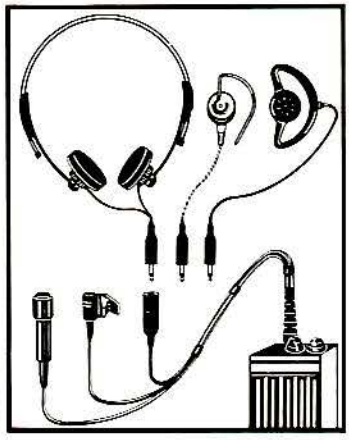
Stephen Katz exits Kustom Electronics, Overland Park, KS, as communications accounts manager to become Midland International's bid and quote specialist.

Cleve Watkins, director of technology and advanced development for cellular systems and RF site products, moves up to vice president of technology at Antenna Specialists, Cleveland.

Former APCO conference manager **Robert Buttgen** joins CET, Edgewater, FL, as marketing and advertising manager.

David R. Siddall transfers from the FCC Mass Media Bureau to become chief of the FCC Office of Engineering and Technology's Frequency Allocation Branch.

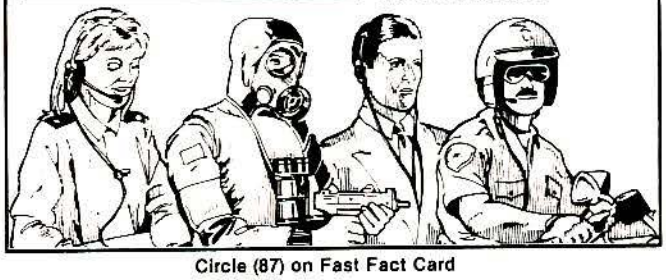
SONIC
Sound Technology Working for You



SONIC HD-13

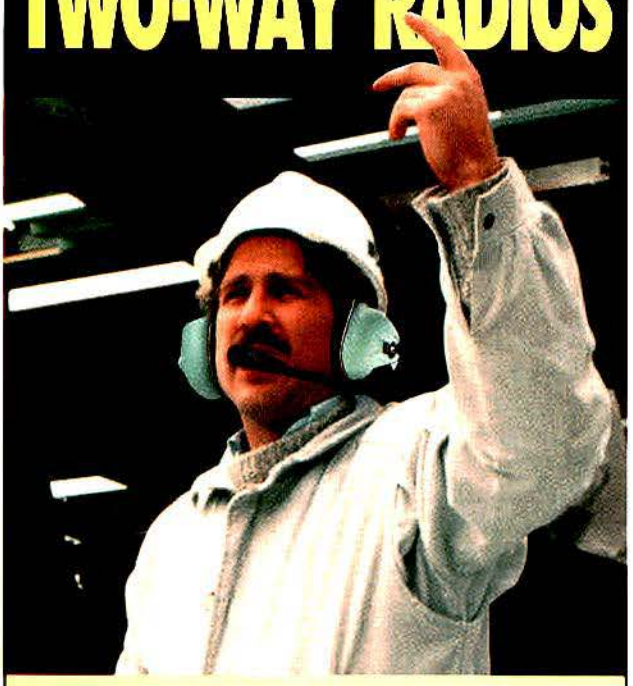
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Circle (87) on Fast Fact Card

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Circle (90) on Fast Fact Card

Calendar

1991

November

14-17—Communications Marketing Conference, Embassy Suites Hotel, Denver. Contact: Gene Johnson, Vega Signaling, 818-442-0782.

22—Radio Club of America Annual Meeting and Awards Banquet, New York Athletic Club, New York. Contact: 201-246-7271.

1992

February

7-13—Cellular Telecommunications Industry Association 1992 Winter Meeting and Exposition, New Orleans. Contact: 202-785-0081.

18-20—International Mobile Communications Expo/Spring, Las Vegas Convention Center, Las Vegas. Contact: 303-220-0600.

March

29-April 1—Energy Telecommunications and Electrical Association '92, Dallas Convention Center, Dallas. Contact: 214-235-0655.

April

12-15—North Central Regional Conference Associated Public-Safety Communications Officers Meeting, Pheasant Run Resort and Convention Center, St. Charles, IL. Contact: T.G. Mieure, 708-244-8640.

May

7-9—1992 Annual Mobile Communications Conference, Westin ANA Hotel and Resort, Washington, DC. Contact: National Association of Business and Educational Radio, 800-759-0300.

11-13—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Hyatt Regency, Denver. Contact: John Tary, 303-452-6111, ext. 443.

13-15—Radiocomm Annual Convention, Montreal. Contact: Lisa La Prairie, 613-233-4888.

17-20—East Coast Regional Conference Associated Public-Safety Communications Officers Meeting, Lancaster Host Resort, Lancaster, PA. Contact: James Giannini, 215-631-6500.

June

21-25—Utilities Telecommunications Council 44th Annual Meeting, Hyatt Civic Plaza, Phoenix. Contact: Rita Clark, 301-621-7802.

July

19-23—Forestry-Conservation Communications Association, Toledo, OH. Contact: Don Pfohl, 602-644-3166.

August

9-14—Associated Public-Safety Communications Officers 58th National Conference, Washington State Convention Center, Seattle. Contact: 800-824-1850.

September

2-4—International Mobile Communications Expo/Fall, Georgia World Congress Center, Atlanta. Contact: 303-220-0600.

21-25—Mobile Communications Marketplace, Moscone Center, San Francisco. Contact: Telocator, 800-326-8638.

October

8-10—Special Industrial Radio Service Association Annual Meeting, Grove Park Inn, Asheville, NC. Contact: Barbara J. Levermann, 703-528-5115.

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Contact Carla Gamino at (303) 762-1249 in Denver to place your classified ad, or send your classified advertising materials and order to **Mobile Radio Technology**, Advertising Department, P.O. Box 12901, Overland Park, KS 66212.

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3 WATT STX 15 SYS TEL CHARGER	$1,195.00

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	$120.00
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GE Mastr II UHF 40 Watt all access	$375.00
GE Delta "S" VHF 40 Watt 16 ch. w/CG, all access	$265.00
MOT MT 500 VHF & UHF 4F & 8F w/PL	$125.00

MOBILES

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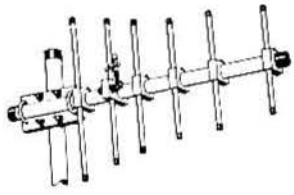
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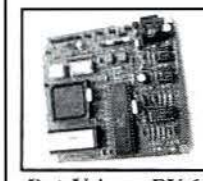
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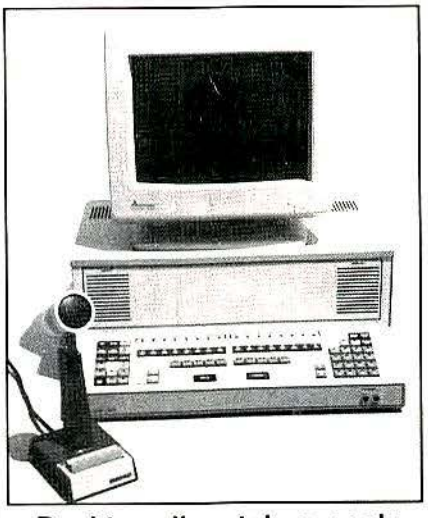
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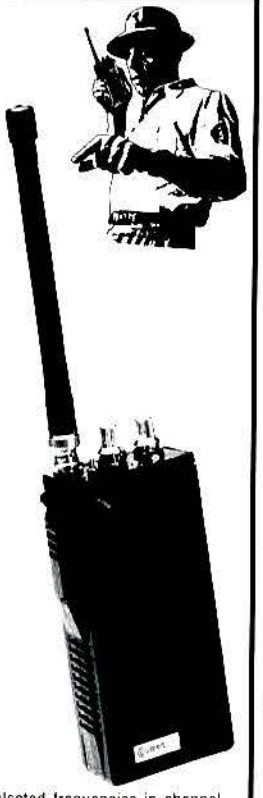
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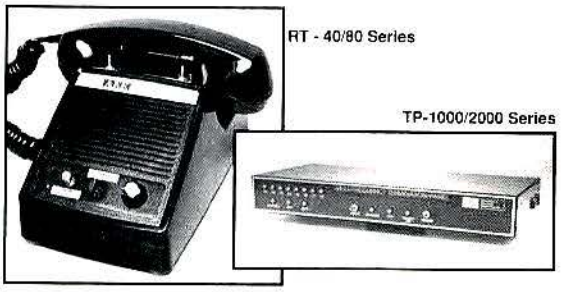
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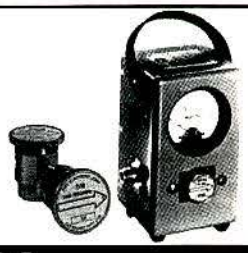
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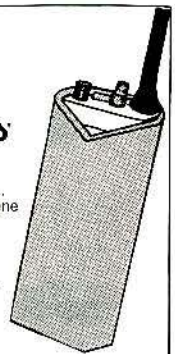
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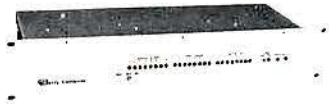
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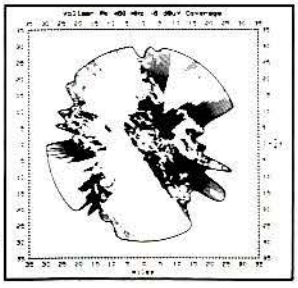
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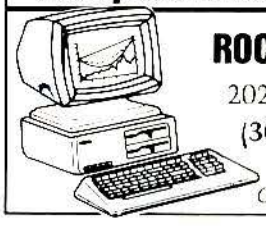
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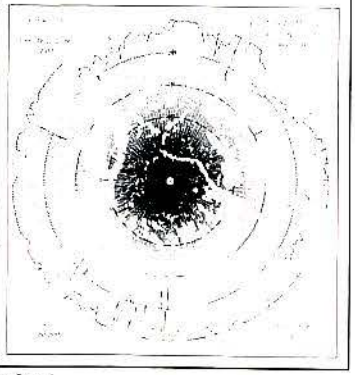
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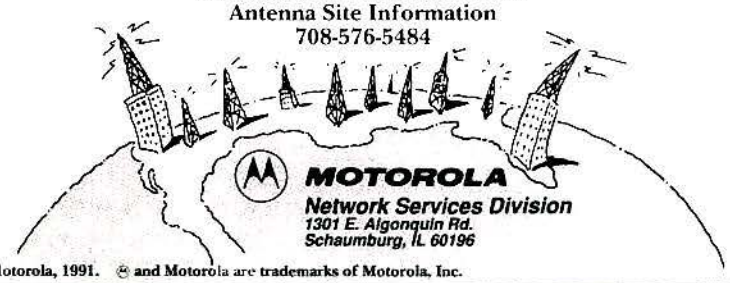
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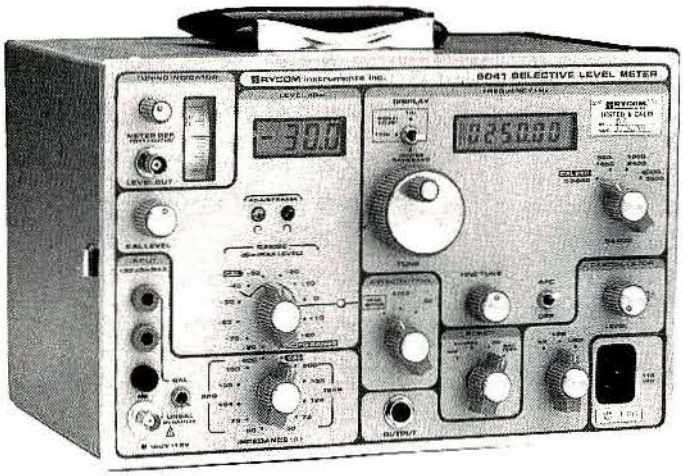
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6. Product Operation Handbook—concise summaries of 220 owner's manuals, plus 130 handset identity drawings. 375 pages. $149
7. Three Book Package—both handbooks above, plus an installation handbook. $295
8. Digital Cellular Radio—history and future of the cellular phone industry. 448 pages. $85
9. Cellular Radio Handbook—a reference for operating cellular systems. 527 pages. $185
10. Inside Cellular—a management business plan for carriers and agents. 197 pages. $185
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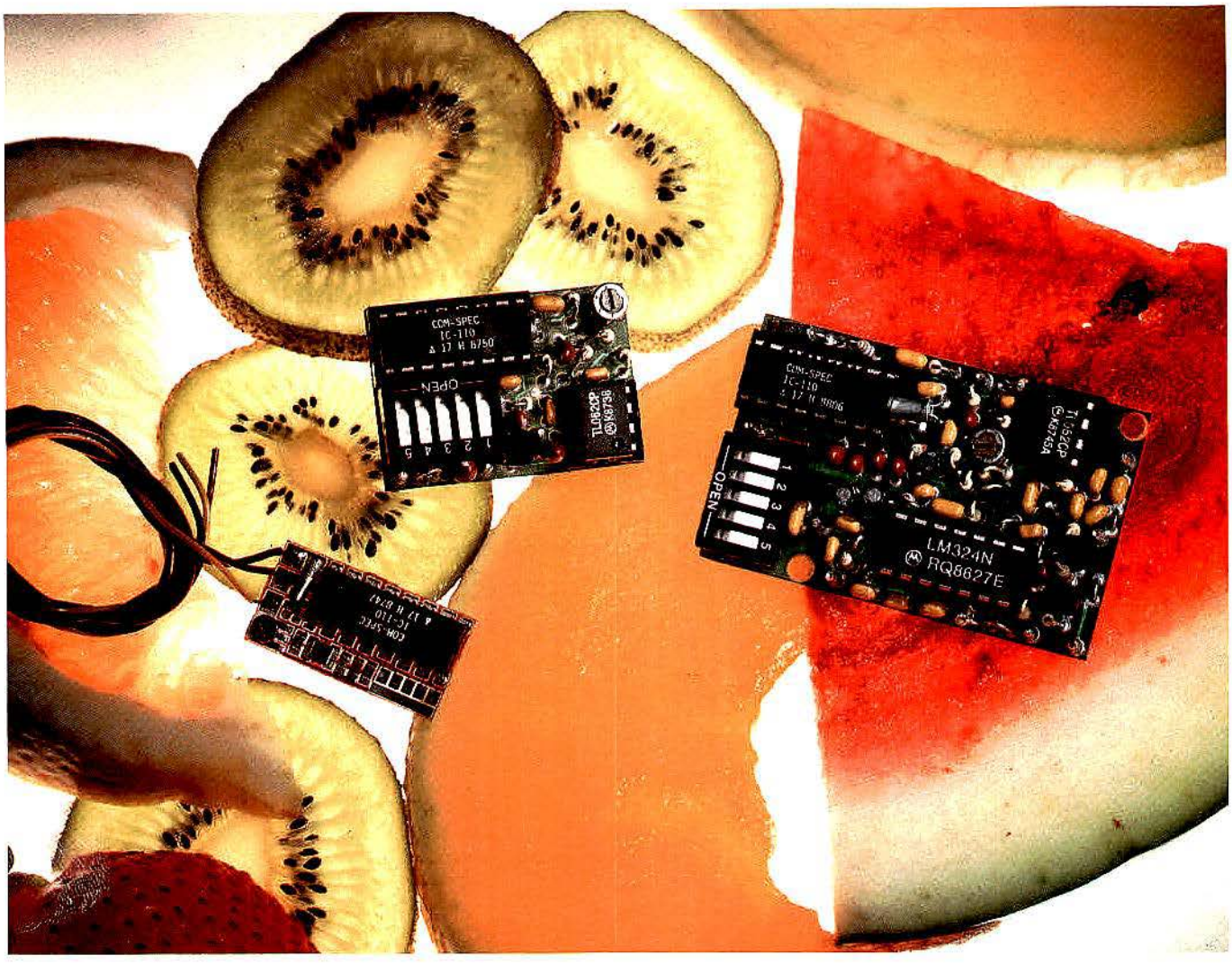
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